THE
CANADIAN ENGINEER

ESTABLISHED 1893

ISSUED WEEKLY IN THE INTERESTS OF THE CIVIL, MECHANICAL, STRUCTURAL ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR

Index to Volume 24

JANUARY—JUNE, 1913

THE CANADIAN ENGINEER

Head Office, 62 Church St., TORONTO

MONTREAL WINNIPEG

INDEX TO VOLUME 24

JANUARY to JUNE, 1913

NOTE.—Figures in page columns refer to the continuous paging of this volume, except in the department of the index devoted to "Contracts," in which the figure in the first column denotes the number of the issue in the volume (26 issues in all), and the second number denotes the page in that issue. As an example, Abattoir, Toronto.................. 13, 70, indicates page 70 of issue No. 13.

AUTHORS.

EDITORIALS.

*Illustrated.

LEADING ARTICLES.

*Illustrated.

*Illustrated.

*Illustrated.

*Illustrated.

CONTRACTS.

*Illustrated.

PERSONAL AND OBITUARY.

*Illustrated.

BOOK REVIEWS.

*Illustrated.

Volume 24. Toronto, Jan. 2, 1913 Contents of this issue on page 115

The Canadian Engineer

An Engineering Weekly

OVERCOMING OBSTACLES IN RAILWAY LOCATION.

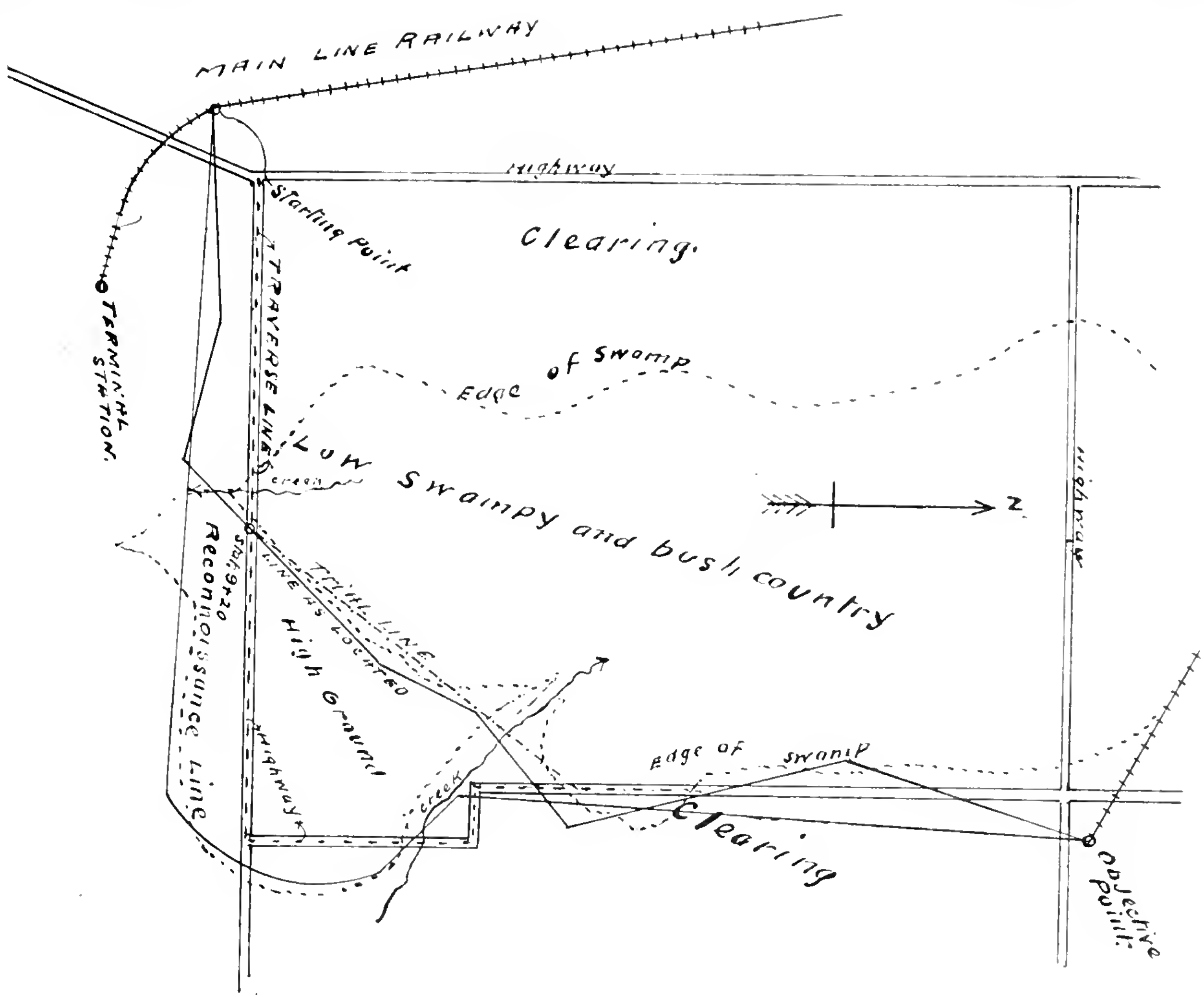
By J. A. MACDONALD.

Greater economy of cost of construction is usually required in an old, settled country than in a new and comparatively unknown one. It was required to run a line on a portion of the Intercolonial from one point to another, a distance of about three and one-half miles, as the crow flies, but over five miles by the reconnoissance route picked out, roughly, by the engineer.

by the four roads, was mostly woods, and known to be almost a solid swamp.

The instructions were to find a cross-country route, if at all feasible, rather than the long round reconnoissance route which, if a long way round, was, however, feasible.

The first thing we did was to run a traverse along the road, as shown in the plan, taking levels as we went along



The engineer had procured a fairly good map of the country, and with this map and provided with barometer, hand-level and compass, drove through the country in a horse and buggy. From the point marked "starting point" on the accompanying map he drove east along the road about two miles to where a road runs northwards towards the objective point. At the junction of those two roads was very high ground. To the left, that is the territory enclosed

and also of setts every 100 feet when we reached the higher ground. This traverse we plotted in both plan and profile. Next we proposed to run a line across through the swamp, starting at stat. 9 + 20, to ascertain the real nature of the country. It might not be as bad as expected. Off our plot we took a bearing for our trial line across the swamp. As we went along with this line we found that, to our right, the swamp ended a short distance from our tangent. Then we

took offsetts to the right as we went along with the line. This line, with the offsetts we plotted on our map, also profiles of the offsetts. In this way we had a definite and complete map of our territory. We found that we could get a good cross-country line. This we plotted out on our map and ran it, thus saving at least one and one-half miles of construction in a line only 3½ miles long as the crow flies, besides getting a line of relatively low cost, as cuts and fills were light.

This method would not, of course, answer in a new country where nothing was known of its topography, but for new work in the older, settled parts of Canada it is almost of absolute necessity. The accompanying map and plan illustrates the methods.

THE USES OF SEWAGE SLUDGE.

By H. P. Bell.

With modern methods of treating sewege the disposal of the liquid effluent is comparatively a simple matter. Since it cannot be made to serve any useful purpose and must eventually be turned into rivers or other open waters, the problem to be dealt with is that of rendering the liquid harmless and inoffensive, and this result can now be attained. The sludge—the separated solid matter—presents greater difficulties, since, although it can be made practically inoffensive, it cannot usually be allowed to accumulate in the neighborhood of cities, unless it is used for filling in land. It is, therefore, not surprising that many attempts have been made to utilize the sludge in some way and thereby to get some return for the rather large cost of handling it. No generally successful way of doing this seems to have been found, though it can be done in certain cases, where the nature of the sewage and the local conditions are favorable.

The solid matter which is usually obtained is a porous material, which retains a very large percentage of water, and two great disadvantages result from this. Firstly, the volume of wet sludge to be handled is very large in comparison with the weight of solid matter which can be utilized, and secondly, the removal of the water is a matter of considerable expense. The percentage of water is frequently as high as 90 per cent.; it may be lower with suitable methods of precipitation and separation, but is hardly ever less than 75 per cent. The greater part of this water must be removed before the material can be of any use.

In China and Japan crude sewage is spread over the fields as a fertilizer, and in China enormous quantities are conveyed for the purpose from the large cities, usually by boats on canals, with which the country is so well provided. The practice is probably very ancient and seems to be effective enough under eastern conditions. Sewage, however, not only has a low value as a fertilizer, but tends to clog the pores of the soil, owing to the great quantity of fine suspended matter which it contains. This difficulty can be got over in the east, where, with a good supply of cheap labor for hand cultivation, the soil can be continually broken and turned over. Experiments in the same direction which have been made in Europe have not given satisfactory results, and in western countries, apart from the necessity of rendering the sludge inoffensive, it must be dried off before it is of any use for agriculture. Even then, its value as a fertilizer is so low that the material can hardly ever be worth the cost of transport to any distance, though it may be worth mixing with richer fertilizers, where suitable conditions are to be found locally.

The use of the sludge as a fuel has been recommended and tried, and may be practicable where plant is in use for producing heat and power by destruction of town refuse; the sludge may also be mixed with coal for use in gas producers. Illuminating gas has been made by heating sludge in retorts, but the cost of manufacture is said to be high in proportion to the value of the gas. For any such purpose the sludge must be dried till it contains only about 25 per cent. of water. The calorific value of the completely dried material is only about half of that of good coal. To produce one pound of sludge dried by heat to 25 per cent. of moisture would take about a quarter of a pound of good coal or more than half a pound of the dried sludge itself.

The recovery of grease from sewage may prove sufficiently profitable, at any rate in places where the sewage contains a fairly high percentage of grease. Among such places are those where the working-up of raw wool is carried on on a large scale. Until lately, the methods of recovery usually took the form of extraction by solvents, such as benzine, etc., and apart from the cost of the solvents, the process was rather troublesome and expensive. A method of driving off the grease by means of steam has been introduced in England by Dr. Grossmann, and is said to give good results; it was referred to recently in The Canadian Engineer.

Two other methods of utilization may be worth mentioning. In one case the sludge is mixed with clay for making bricks, and this seems to be more particularly applicable to sludge which has been precipitated by means of lime. In the other case the sludge is used for briquetting coal dust. In both cases the value of the sludge consists in its plasticity. When incompletely dried the sludge is usually a tough and rather rubber-like material and may well serve to give plasticity to a poor clay.

Most large cities which are on or close to the sea make no attempt at utilization of their sewage sludge, which is carried out to sea and dumped in deep water. London, for instance, keeps a fleet of hopper barges for this purpose. At inland places, where the difficulties of disposal are much greater, there seem to be better chances for some kind of utilization, but it is likely that whatever is done in this direction will be done on account rather of local necessities than of any value which may be got from the results.

ONTARIO'S GOLD RESOURCES.

Gold bullion was produced at fourteen properties in Ontario last year, from none of them in large quantity. The principal contributor was The Canadian Exploration Company at Long Lake. At Porcupine the Hollinger and Vipond mines operated small test mills previous to the fire, and the Dome recovered considerable gold in the laboratory. Other producers were the Kenora (formerly Mikado) and Olympia, both at Shoal Lake; St. Anthony (Sturgeon Lake); American Eagle and Detroit Syndicate, in Munro township; Gold Pyramid, in Guibord township; Swastika; Havilah (formerly Ophir); Dr. Reddick (Larder Lake), and the Tingley prospect (Pelican Lake). The number of men employed at the foregoing mines was 597, to whom wages were paid amounting to $442,519. It is evident from these figures that most of the labor was employed in development and construction work, is Mr. T. W. Gibson's summing up in the twenty-first annual report of the Ontario Bureau of Mines.

The revival of interest in gold mining caused by the discoveries at Porcupine and the developments now under way there has put new life into a number of the older fields, which for years have lain dormant.

SPECIFICATIONS FOR ROADS OF DIFFERENT TYPES.

The following specifications are those used by Chief Engineer E. A. James, of the Board of Highway Commissioners of York County, Ontario, on the roads being built under his design and supervision throughout the county of York:

Specifications for Dolarway Pavement.

PREPARATION FOR THE ROAD BED.

1. All streets, prior to laying the pavement thereon, shall be graded as directed by the Engineer. After excavating the sub-grade unless the Engineer deems the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to sub-grade with sand, cinders, gravel or broken stone.

2. When the street shall have been graded and shaped to its proper form, it shall be thoroughly rolled with a roller weighing not less than six tons, to a thoroughly compact surface. If the ground is wet, cinders, sand or gravel are to be put on before rolling.

3. Any depression discovered after this rolling shall be filled to sub-grade, re-rolled, and this repeated until a roadbed perfect as to grade and form shall have been made.

4. When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the Engineer.

CONCRETE FOUNDATION.

5. Upon the sub-grade thus formed shall be placed a layer of Portland Cement Concrete seven inches thick to be made as follows:

The concrete for the base shall be so proportioned that the cement shall overfill the voids in the fine aggregate by at least five (5) per cent., and the mortar shall overfill the voids in the coarse aggregate by at least ten (10) per cent. The proportion shall not exceed one (1) part cement to eight (8) parts fine and coarse aggregates.

When the voids are not determined the concrete shall have the proportion of one (1) part cement, two and a half (2½) parts fine aggregate and four (4) parts coarse aggregate.

The method of measuring the materials for the concrete, including water, shall be one of which will insure separate uniform proportions at all times. A bag of cement (94 pounds) shall be considered to have a volume of one (1) cubic foot.

6. The gravel to be free from clay or other injurious material and shall contain no stone over two and one half (2½) inches in diameter.

7. If broken stone is used for concrete it shall be of the best quality of limestone, or other stone equally good, and shall be broken to such a size that the fragments shall not be larger than will pass through a 2½-inch ring and not smaller than ½ inch in its longest direction. It shall be free from dust, dirt, loam or other injurious material and shall be screened when necessary to remove dust and small particles.

8. The cement used in the work will be submitted to the tests approved and recommended by the Canadian Society of Civil Engineers, and any Cement failing to comply with these requirements, shall be rejected. All Cement used in this work shall be suitably protected from exposure to moisture until used.

9. After the sand and cement have been thoroughly mixed dry, in a mixer approved by the Engineer, enough water shall be added to produce a mass that will settle in place without tamping and not so thin that water will show on the surface.

10. Extreme care should be taken that the sub-grade is kept moist while this concrete is being put in place.

11. No re-tempering of concrete will be permitted, and that in which mortar has begun to set, shall be rejected.

12. No concrete shall be laid when the temperature at any time during the day or night falls below thirty five (35) degrees above zero, Fahrenheit.

13. Suitable Expansion Joints shall be provided at each curb line and at points every fifty feet across the roadway. The transverse joints shall not exceed three-quarters of an inch in width, and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement and be filled with DOLARWAY BITUMEN and fine sand. Great care shall be taken to fill these joints flush with the surface of the pavement, before the wearing surface is applied.

WEARING SURFACE.

14. After the concrete has been laid as above specified, and is perfectly clean and dry, there shall be spread over the entire surface a layer of DOLARWAY BITUMEN, using not less than one-third of a gallon to the square yard, said bitumen to be applied at a temperature of not less than 175 degrees Fahrenheit or more than 200 degrees Fahrenheit.

Immediately following the spreading of the Bitumen there shall be spread over the entire surface a uniform layer of dry, clean granite, trap or other approved rock screenings, using not less than one (1) cubic yard to one hundred and fifty (150) square yards of surface. No bitumen shall be applied when the temperature is below 40 Fahrenheit and the screenings shall be applied while the bitumen is sufficiently soft for the sand or screenings to be imbedded in it and unite with it. After the screenings are spread, the street shall be closed to travel for a period of not less than two (2) hours, after which the street may be opened to travel.

PATENTS:

15. All fees for any patent invention, article, agreement, or other apparatus that may be used upon or be in any way connected with the construction, erection or maintenance of the work, or any part thereof, embraced in the contract or these specifications, shall be included in the price stipulated in the contract for said work, and the contractor or contractors must protect and hold harmless the Corporation against any and all demands for such fees or claims. At least two trademark plates for every 200 lineal feet or less of pavement shall be set by the Contractor at conspicuous places in the pavement.

16. The contractor shall furnish a satisfactory surety bond guaranteeing the maintenance of the pavement during the period of three (3) years from and after the date of completion of the same. The maintenance, however, shall not include any damage to the pavement or to the foundation thereof, or to any of the damage items of work embraced by the contract, which may be incurred by action beyond the control of the contractor.

SPECIFICATIONS FOR BRICK PAVEMENT WITH CONCRETE FOUNDATION

CONCRETE FOUNDATION.

Preparing sub-grade.—The sub-grade is to be formed to the levels and cambers shown on sections; where the ground is soft or otherwise unsuitable it shall be removed and refilled with gravel, broken stone or other approved material, the whole sub-grade shall then be thoroughly rolled with a roller weighing at least eight tons, any depressions discovered after this rolling shall be filled with approved material and re-rolled until brought to the proper levels and camber.

Filling in embankments must be applied in layers of eight (8) inches in thickness and each layer thoroughly rolled.

Tile drains shall be placed under the edge of the concrete or in such places as shall be directed by the Engineer.

Concrete foundation.—When the sub-grade has been completed a layer of Portland Cement Concrete 5 inches thick shall be placed.

The broken stone for the concrete shall be hard quality limestone, free from all refuse and foreign matter, with no fragment larger than will pass, in its longest dimensions, through a 2½-inch ring, and not smaller than half an inch in its longest dimensions.

The sand is to be clean sharp sand and free from clay or other injurious material and to be thoroughly dry when first mixed with the cement.

The cement used shall be an approved brand of Portland Cement, and will be submitted to the tests approved and recommended by the Canadian Society of Civil Engineers, and any cement failing to comply with these requirements shall be rejected. All cement used in this work shall be properly protected from moisture until used.

The water used for mixing the concrete shall be reasonably clean, free from oil, sulphuric acid and strong alkalies. The cement and sand are to be first thoroughly mixed in a dry state until the whole mass shows an even shade, sufficient water shall be added to produce a plastic mass, fluid enough to settle in place without tamping, but not so thin that water will show on the surface. The broken stone must be damped before being added to this mixture, the whole mass to be thoroughly mixed or turned over at least three times, so that every fragment is coated with cement mixture.

The concrete shall be so proportioned that the cement shall overfill the voids in the sand by at least 5 per cent. and the mortar shall over-fill the voids in the stone or gravel by at least 10 per cent. The proportion shall not exceed one part of cement to eight parts of the other materials. When the voids are not determined the concrete shall have the proportions of one part of cement to three parts of sand and five parts of stone. A sack of cement (94 pounds) shall be considered to have a volume of one cubic foot.

The concrete shall be laid while fresh and within twenty minutes after it has been laid it shall be struck off with a template, and as soon as practical trowelled sufficiently to bring the finer particles to the surface and then broomed. When the surface is finished it shall be kept wet for seven days. Care should be taken that the sub-grade is kept moist while this concrete is being put in place. The whole of the concrete must be thoroughly tamped and no re-tamping will be permitted. No concrete shall be laid when the temperature at any time during the day or night fall below 35 degrees above zero Fahrenheit.

Expansion joints shall be provided at each curb-line and at points every 25 feet across the roadway. The transverse joints shall not exceed three-quarters of an inch in width and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement and shall be filled with asphaltic paving cement; great care shall be taken to fill these joints flush with the surface of the pavement, and that no dirt, stone, etc., be left in the joints.

SAND CUSHION.

On the concrete foundation shall be spread a ¾-inch cushion of clean sand, free from loam and foreign matter, and sufficiently fine so that it will pass through a (¼) one-quarter-inch mesh; the sand must be spread by means of a template made to conform to the true curvature of the street cross sections, the compression to be done with a hand roller weighing from three hundred to four hundred pounds.

BRICK PAVING.

The bricks used for paving shall be sound, well-burnt paving bricks, showing at least one fairly straight face, free from cracks and excessive laminations, preferably made from shale. They shall be not less than 2½ in. x 4 in. x 8 in., or more than 3¾ in. x 4 in x 9 in., and shall not vary one-fourth (¼) of an inch in width or depth or more than one-half of an inch in length. The brick shall be reasonably perfect in shape, free from marked warpings or distortion. The bricks shall be carefully laid on edge, with best edge uppermost, as compactly as possible, in straight course across the street, with the length of the bricks at right angles to the axis of the street. Whole bricks only shall be used, except in starting and finishing courses, all fractional batting to be next to the curbs.

Expansion joints shall be provided at each curb line and at points 25 feet apart across the roadway. The transverse joints shall not exceed three-quarters (¾) of an inch in width, and the longitudinal joints shall be one inch in width. These joints shall extend the entire depth of the pavement, and shall be filled with asphaltic paving cement; great care shall be taken to fill these joints flush with the surface of the pavement and that no dirt, etc., be left in the joints.

After 25 or 30 feet of the pavement is laid, every part shall be rammed with a heavy rammer, a plank laid on the surface parallel to the curb to receive the blows of the rammer, or a steam roller not to exceed five tons may be used. When a steam roller is used it shall first be passed slowly back and forth parallel with the curb until the bricks are firmly imbedded in the sand cushion, the pavement shall then be rolled the entire width of the street transversely at an angle of 45 degrees to the curb, repeating the rolling in like manner in the opposite direction. All broken or injured brick must be taken up and replaced with satisfactory ones, which must be brought to true surface by tamping.

FILLER.

The filler shall be composed of one part of clean sharp, fine sand and one part of Portland Cement, thoroughly mixed dry in small quantities, water is then to be added until a mixture is of the consistency of thin cream, which shall be kept in constant motion until all used up. The filler shall be poured into the joints until it appears on the surface.

The sides and edges of the bricks shall be thoroughly wet by sprinkling before the filler is applied. Care shall be taken that the joints are free from sand, etc., before the filler is applied. After the filler has hardened, a half inch coating of sand shall be spread over the whole surface of the pavement; in dry weather this coating shall be kept damp by sprinkling for three days.

SPECIFICATIONS FOR ROCMAC ROAD

Sub-grade.—Before the base course is laid the roadbed shall be shaped to the proper levels and cross-sections and thoroughly rolled with a roller weighing at least ten tons.

After excavating the sub-grade, unless the Engineer deems the natural ground a proper foundation, excavation shall be continued until solid ground is reached and then refilled to sub-grade with sand, cinders, gravel or broken stone.

Any depression discovered after rolling shall be filled to sub-grade re-rolled and this repeated until a roadbed perfect as to grade and form shall have been made.

When the use of the roller is impracticable, the foundation must be thoroughly puddled and rammed until compacted to the satisfaction of the Engineer.

Base Course.—The base course shall consist of best quality limestone, broken so as to pass through a 4-in. ring by its longest dimensions and be retained on a 2-in. ring spread and rolled to a finished depth of four inches.

The base course shall be thoroughly rolled with a heavy roller until the surface supports the roller without yielding.

On the base course shall be spread a coating of ½-inch. limestone screenings, which shall be rolled into the interstices until a sufficiently firm surface is obtained to prevent the Rocmac matrix from penetrating the base course. If thought necessary by the Engineer, the base course and screenings shall be watered before the Rocmac is put in place.

Rocmac Matrix.—The Rocmac matrix shall be composed as follows: one-third cubic yard of limestone crushed to pass through a one-fourth web screen and containing 50 per cent. limestone dust; add to this five gallons of Rocmac solution and thoroughly mix on a mixing board into a stiff mortar and at once spread on the base course.

The limestone shall be dampened to facilitate the chemical action of the solution.

The Rocmac matrix shall be spread on a base course to a depth of 1 1/3 inches or about 1/3 cubic yard of matrix to 9 sq. yards of road surface for each additional inch of pavement 1/3 inch is added to the depth of the matrix.

Top Course.—The material for the top course shall consist of trap rock from an approved quarry, broken to pass a 2½-inch ring and be retained on a 1½-inch ring. The trap rock shall be put in place immediately after the spreading of the matrix in such quantities as will give a finished depth of 3 inches sprinkled with water and rolled with a roller weighing ten tons.

The road is to be rolled rapidly until the matrix appears on the surface, and is then rolled as slowly as possible; as the matrix rises it is to be brushed with a hand-broom so as to prevent it lying in particles.

If the stones are picked up from the road by the roller wheels the latter are to be sprinkled with water.

The roller is to be continued until the whole surface of the road is thoroughly flushed up with the matrix and supports the roller without yielding; the surface is then to be spread with a thin coating of limestone dust to absorb excess of solution and to form a cushion while the process of setting is going on.

SPECIFICATIONS FOR WATERBOUND MACADAM PAVEMENT

M. 1.—BROKEN STONE.

The contractor shall submit with his bid a written statement of the quarries, ledges or other source of supply from which he proposes to obtain the stone for the road, together with a sample of such stone weighing at least 30 pounds. If the proposed quarries are developed and a uniform product satisfactory to the Engineer can be obtained from them, this will be accepted and the contractor will be so informed. If after trial it is found that for any reason product from any source at any time proves unsatisfactory to the Engineer, he may decline to continue its use and can require the contractor to develop other quarries of source of supply, and the contractor shall have no claim for increased payment on account of such requirement. If the qualities of the sample of stone submitted are satisfactory to the Engineer and are accepted by him, the sample will be retained and all stone brought on the road inferior in character to the sample will be rejected. All broken stone used must be hard and compact and of uniform character. It must have enough cementing value to thoroughly bind the surface of the road after rolling. The broken stone shall have the rough surface of fracture, and shall be as nearly cubical as possible. It shall be free from earth or other objectional material, and screened to the required sizes. No soft, disintegrated stone shall be used.

M. 2.—DRAINAGE.

The side ditches and gutters shall have true grades and sufficient incline as provided in the plans and profile to furnish a free and uniform flow of water to the nearest natural outlets of culverts. Where natural outlets are utilized, they shall be so improved where necessary as to carry the water quickly away from the highway. The ditches must conform in all cases to the standard cross-sections for the class of road which is being improved.

SHAPING SURFACE OF SUB-GRADE AND SHOULDERS.

Before the broken stone is spread, the roadbed shall be shaped to a true surface, conforming to the cross-section of the highway, and thoroughly rolled by the steam roller. If the road shows a wavy motion after passing the roller over it three or four times, it may indicate too much moisture in the sub-grade. If on examination this is found to be the case, the rolling should be stopped, the roller moved ahead, and time allowed for the sub-grade to dry out.

M. 3.—SCARIFYING.

When called for on the plans or ordered by the Engineer, the old macadam surface shall be thoroughly scarified by hand or with a mechanical scarifier of an approved type, to the width and depth shown on the plans, after which the loose stone shall be raked to a uniform grade and crown.

M. 4.—MACADAM.

The width of the macadam shall be . . . feet, unless otherwise shown on the plans. The macadam road shall be laid in layers of courses, as follows:—

First Course.—First course shall have a thickness of four inches after rolling, and shall consist of limestone that will pass through a 4-inch screen and be retained on a 2-inch screen. No piece shall be more than four inches in length.

The broken stone in this course shall be spread evenly over the sub-grade to such a depth that they will have, when rolled, the required thickness of three inches. Each layer shall be rolled with a self-propelled roller, weighing not less than ten tons, until the broken stone shall not creep ahead of the roller and is thoroughly compacted to the satisfaction of the Engineer. Rolling must, in all cases, begin at the sides of the road and work towards the centre. Under no circumstances shall the centre be rolled first. In case the Engineer should consider it advisable, a thin course of screenings may be spread over this layer of the compressed stone and rolled. If any depressions occur during or after the rolling they must be filled with broken stone of the size that has been used in the course and re-rolled until a firm, even surface is obtained and the course has the required thickness. The Engineer may at any time during the laying of the broken stone require the roller to be operated sixteen hours each day, and the contractor must provide the extra shift operators when so required.

With certain rocks it has been noted that after the roller passes over them a few times, they fail to compact and the sharp edges are broken off. A slight sprinkling of sand or stone screenings or water may prevent this. One after another of these should be tried until the work progresses to the satisfaction of the Engineer. In the case of heavy fills, the roller must not be run to the outer edge of the shoulders unless the fill has had time to settle. The roller should be worked out slowly under these conditions.

Second Course.—The second course shall have a thickness of three inches after rolling, and shall consist of granite stone, which shall pass through a two-inch screen and be retained on a three-quarter-inch screen. No piece shall be more than two inches in length. Broken stone shall be placed and spread, as specified for the first course, and spread to such a depth that it will have when rolled the required thickness. Second course shall be rolled with a self-propelled roller weighing not less than ten tons, until it is completed to form a firm, smooth surface approved by the Engineer. Rolling must in all cases begin at the sides of the road and be worked towards the centre, and care be taken to preserve the grade and the crown of the road. If any depressions occur during or after the rolling they must be filled with broken stones of the size specified for the second course and re-rolled until a firm, even surface conforming to grade and cross-sections is obtained.

M. 5.—WATER-BOUND MACADAM SCREENINGS.

After the two courses above described are thoroughly compacted to the satisfaction of the Engineer in charge, broken limestone screenings that will pass through a three-quarter-inch screen and containing dust of fracture shall be spread in a thin layer over the course of stone and sprinkled sufficiently to wet it thoroughly, but not so much as to saturate the foundation, then rolled and more screenings applied, sprinkled and rolled, until the voids in the course of stone is just covered. Each application of screenings shall be sprinkled until hard and smooth to the satisfaction and acceptance of the Engineer in charge. Screenings shall be applied from piles at the sides of the road, sprinkled from wagons or carts and shall not be dumped on the sub-grade nor upon the layer of course stone in advance of the final surfacing. The Engineer will not permit any travel upon the layer of screenings before rolling. The binder course in all cases must only be sufficient to completely fill the voids and just cover the course of stone after it has been rolled separately and evened up with stone of the same sizes as have been used in that particular course. During final rolling of macadam the earth shoulders outside of the macadam shall be thoroughly compacted by rolling and sprinkling. Any part of macadam that cannot be reached by the roller shall be thoroughly tamped by hand rammer.

M. 6.—GRAVEL SHOULDERS.

Where directed by the Engineer gravel that will pass an 1½-inch ring and composed of hard, durable stone and assorted sizes of finer materials sufficient, but not more than sufficient, to fill the voids, and shall be three inches thick after rolling.

It shall be sprinkled until thoroughly wet and rolled with a self-propelled road roller weighing approximately ten tons until smooth and thoroughly consolidated.

M. 7.—SHOULDER DRAINS.

Shoulder drains shall be constructed according to the plans, on either side of the roadbed, where found necessary by the Engineer.

M. 8.—METHOD OF CARRYING ON WORK.

This improvement shall be started at the end of the road farthest from the source of supply of the broken stones, unless otherwise ordered by the Engineer. All courses of stone shall be carried along as nearly together as practicable. Each course, after being spread, shall be promptly rolled and covered with the next course as soon as possible. No allowance or extra compensation will be made for material driven into the sub-grade, or for mistakes made by contractor in preparing sub-grade.

Before the road will be finally accepted the broken stone surface must be hard, smooth, regular and well-balanced. The shoulders must be rolled down to grade with the required slope to the ditches and thoroughly compacted. Side ditches must be brought to an even grade and provided with outlets as directed by the Engineer, and must be clear of all obstruction.

M. 9.—HIGHWAY INTERSECTIONS AND DRIVEWAYS.

At all highway intersections, private driveways or entrances macadam shall be carried ont to full width of the roadbed, at least twelve feet from the centre line, as specified or shown on the plans or as directed by the Engineer in charge.

M. 10.—ROLLING.

Include all rolling necessary to thoroughly compact the sub-grade and broken stone, and in finishing and binding the road.

M. 11.—SPRINKLING.

Include all sprinkling with water required by the Engineer in the construction and finishing the road.

M. 12.—ALTERNATE BIDS.

In each case where an alternate bid is snbmitted such bid must be accompanied by drawings, cross-sections and a complete description of the materials used and the method of construction employed in building the same. Each alternate bid must further contain the following clause written into such bid:

The prices stated in this tender and stipulated in the contract must be understood to cover every contingency, the furnishing of all labor, materials, power and plant which may be required for the performing and completing of the work described in these specifications and for maintaining same in good order for a period of one year from date of acceptance of the work by the Board of Highway Commissioners for York.

M. 13.—

The work must proceed as rapidly as conditions will allow and not less than 500 lineal feet per week must be completed.

WIDTH OF TIRES.

With the growth of Toronto, the interurban and suburban traffic on our highways has increased, and, with the increase, in the volume of traffic, there has been an increase in the tonnage carried per inch of tire.

Narrow tires carrying heavy loads have a very destructive effect upon the road surface, while wide tires from the point of view of maintenance are desirable. The concentration of the heavy load on a narrow tire has the effect of cutting the road surface, while the same load on a sufficiently wide tire would act as a roller and on improved roads it would be even better if the front end and rear wheel did not track. Wide tires must not be carried to excess, for we will find on a well-crowned road a tire of 5 inches in width would only come partly in contact with the road and the load would be carried on one edge of the tire and the same cutting effect will occur as with a narrow tire.

The wide tire is a distinct disadvantage on bad roads, so that (under present conditions) with a few improved and many unimproved roadways, the question of narrow vs. wide tires is one that will require careful consideration.

If improved roads are to be cheaply maintained there must be a ratio fixed between the width of tire and the load carried for at the present time our roads are requiring to take traffic which is extremely injurious.

The steamship "Vanellus," the latest addition to the fleet of the Cork Steam Ship Company, Limited, Cork, sailed from the Tyne on Tuesday, the 10th inst., on the completion of a very successful trial trip.

The steamer has been built and engined at the Neptune Works of Swan, Hunter & Wigham Richardson, Limited. She is 285 feet in length by 38 feet beam, and carries over 2,700 tons deadweight on 19½ feet draft. She has been constructed to attain the highest class in Lloyds' Register, has accommodation for a few passengers, and is in every way a cargo steamer of the highest class.

Her propelling machinery, which consists of a set of triple expansion engines, supplied with steam by two boilers, and the whole of which have been constructed at the Neptune Works of Swan, Hunter & Wigham Richardson, Limited, worked on the trial trip without the slightest hitch, and gave satisfaction to all concerned, driving the vessel at a speed of over 12 knots per hour.

The owners were represented on the trial trip by Capt. Hore, of Liverpool, their marine superintendent, and by Mr. Flockhart, of Liverpool, their superintendent engineer. After the trial trip, the vessel sailed to take up her station in the company's service between Liverpool, Manchester and Dutch and Belgian ports.

THE BRIDGE OF THE CANADIAN PACIFIC RAILWAY AT LACHINE, P.Q.

In connection with the double tracking of the Canadian Pacific Railway it became necessary to change the bridge which crosses the River St. Lawrence at Lachine, and which is located about two miles above the Lachine Rapids, from a single-track structure to accommodate the double tracks. Some months ago the engineers began the preparation of plans for the widening of the bridge. In order to effect this work it was necessary to change the old structure to a great extent. In the issue of *The Canadian Engineer* of January 18, 1912, the work of enlarging the old piers, which was undertaken by the Foundation Company, of Montreal, was described.

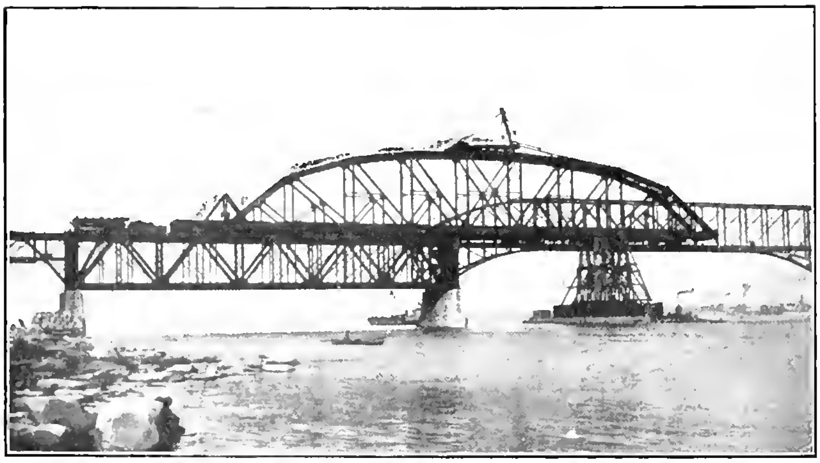


Fig. 1.—Floating One of the New Spans into Position.

It was on July 12, 1910, that the first operation was made on the enlargement of the old piers to carry the new girders before any of the new steel could be swung. This in itself was a huge job, and the Foundation Company undertook to complete the first eleven piers during the first season. However, this was not accomplished, but was completed by November 8, 1911, leaving only one pier on the up-stream side to be finished when the cantilever is taken out. The work on the superstructure was commenced on March 15, 1911, when the placing of the two eighty-deck plates was first undertaken.

The bridge, when completed, will have a total length of 3,138 feet, consisting of six 80-foot deck girder spans, two 122-foot deck truss spans, fourteen 120-foot 8-inch deck truss spans, eight 238-foot 6-inch deck truss spans, four 268-foot 4-inch deck truss spans, four 405 foot 7-inch through truss spans, two 119-foot 2-inch deck truss spans.

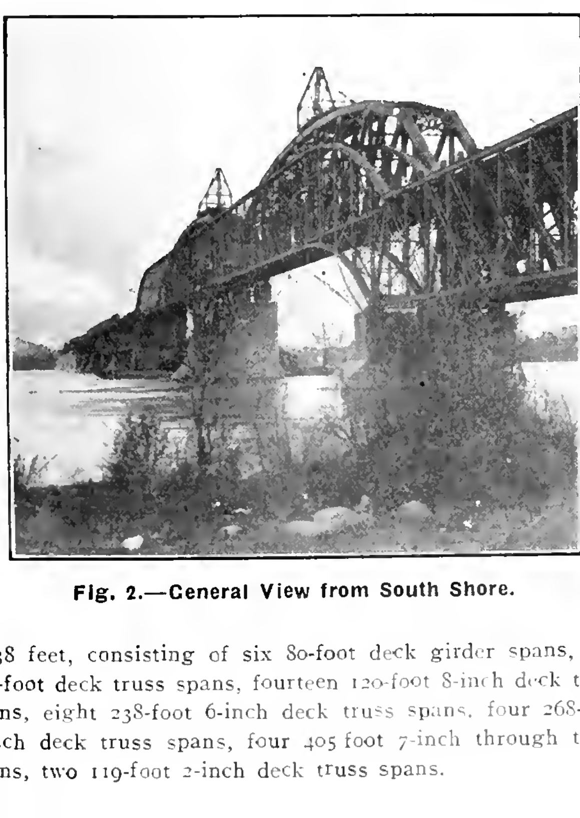


Fig. 2.—General View from South Shore.

The erection of steel was begun at the Highlands end, and by working from the old bridge the new spans for the second track east of the old track were placed out to pier No. 7. By sliding the old 240-foot span and the two new 120-foot spans between piers 6 and 7 it was possible to place a crossover about at pier 6 and turn the traffic over the new east track from that point to the shore. The old structure under the west track was then removed between pier 6 and the shore and the new superstructure placed. The erection of the east half between piers 7 and 12 was then completed and a crossover between piers 11 and 12 was made by slewing the outer end of these two spans so that the new span connected the east side of pier 11 with the west side of pier 12. Traffic was then turned over the east track between pier 12 and the Highlands shore, and the old structure between piers 7 and 12 was dismantled and the new spans were placed. The approach span on the Caughnawaga side between piers 14 and 15 was completed about the same time as the eastern spans between piers 7 and 12, and when traffic was turned over the west track between pier 12 and the Highlands shore the new through truss channel spans for the east track were erected over the deck approaches on either side. The channel spans will be pushed out to place by mounting the back ends on rollers so they can slide over the approach spans, the front ends being carried on scows floating in the river. When these spans are in position, traffic will be turned over this track for the entire length of the bridge, while the south approach span and two channel spans on the west track are

Fig. 3.—View Showing Old and New Spans from the South End.

placed. It is expected that this work will require several months to complete.

It is interesting to note that in the new bridge there are no less than 8,072,252 lbs. of steel. The eight-ft. lengths run 110,000 lbs., the 120's 226,000 lbs., the 240's 960,000 lbs., the 270's 1,324,138 lbs., and the 480's 2,600,000 lbs.

Fig. 1 is taken from a photograph secured while one of these large spans was being floated into position.

The spans were erected at the yards of the Dominion Bridge Company, which are in close proximity to the bridge, connected by a spur line, and as soon as finished were re-erected on the finished deck plate portion of the bridge on the Caughnawaga side of the stream, where space sufficient in length had been left for the purpose.

Fig. 2 shows the old and new spans and it is made from the south end. A view of the entire work from the south shore is shown in Fig. 3.

The design of the new bridge was made under the supervision of Mr. P. B. Motley, engineer of bridges, Canadian Pacific Railway, and the construction work is being supervised by Mr. J. H. Barber. The Foundation Company, of Montreal, built the piers and furnished the equipment on the deep-water piers. The equipment for the piers in shallow water was furnished by the C.P.R., and the work was handled by their men. The Dominion Bridge Company, of Montreal, fabricated and erected the steel superstructure.

BITUMINOUS PAVEMENTS FOR CITY STREETS.*

By George W. Tillson.†

The first asphalt pavement of any quantity in this country was laid in 1877 on Pennsylvania Avenue, in Washington, and since that time it has been in general use all over the country. In 1890 in the eight cities of Boston, Brooklyn, Buffalo, Chicago, New York, Philadelphia, St. Louis and Washington, there were 246 miles of asphalt pavement. So great was its popularity that in these eight cities in 1911 there were 2,348 miles.

The hard asphalts have undoubtedly been formed by natural distillation of oils. In the refining of the petroleum oils of California, however, it was discovered that after evaporating the volatile oils an asphalt residuum was obtained. These California oils are different from the Ohio or Pennsylvania petroleums, as these latter, when distilled, produce paraffine rather than asphalt; consequently the Eastern oils are said to have a paraffine base while the California oils have an asphaltic base. Similar oils also have been discovered in Texas, Mexico and on the Island of Trinidad.

The natural asphalts are too hard for direct use in pavements and must be fluxed with some softer material, either an asphalt or a paraffine flux. This mixture of asphalt and flux, after it is prepared for the pavement, is known as asphaltic cement, and as this is the material to be actually used it has been thought by many that specifications for asphalt should specify tests for the asphaltic cement without any regard for the asphalt itself. In the present stage of the industry it would seem to the writer that this is hardly a safe proceeding. A natural, hard asphalt may possibly be fluxed with a certain material so that it will make an asphaltic cement that will be satisfactory in every way at the time it is made, but when laid upon the street and subjected to the action of the atmosphere the lighter parts of the flux may volatilize, so that the pavement will crack badly.

Construction of Pavement.—It is assumed that the pavement is laid upon a stable foundation. This is an important feature in all structures, and particularly so in an asphalt pavement, as the asphalt is simply a carpet, the foundation being the floor which must sustain the actual load. The wearing surface proper is made up of asphaltic cement, sand and mineral dust. The sand is really the wearing part of the pavement, the function of the asphalt being simply to hold the particles of sand together and of the mineral dust to supplement the sand by partially filling its voids so that when mixed with the sand and the asphalt the mixture will be as dense as possible. This is necessary not only to obtain a surface that will best resist the action of traffic, but also to prevent the absorption of water, which would cause disintegration and decay.

There has always been more or less discussion as to the size of the sand to be used. The following classification, it is believed, would produce a first-class pavement, other conditions being satisfactory.

Per Cent. Composition of Standard and Permissible Asphalt Pavements.

	Standard Heavy.	Limits.	Standard Light.	Limits.
Bitumen	11	10.5—12.5	10	9.5—10.5
Passing 200-mesh ...	12	10 —14	10	8 —12
Passing 80-mesh ...	26	22 —30	12	10 —14
Passing 40-mesh ...	34	30 —38	38	34 —42
Passing 10-mesh ...	17	14 —20	30	26 —34
Penetration 77° Fahr.	45	40 —55	65	55 —75

The relative proportions of the asphaltic cement and the sand and dust to be used will depend upon both the character of the sand and the asphaltic cement and the traffic of the street, as well as climatic conditions. The refined Trinidad asphalt contains approximately 55 per cent. of bitumen, Bermudez asphalt 95 per cent., and the oil asphalts generally 99.5 per cent., and the flux can be considered as being 100 per cent. bitumen. It will be seen that a cement made of these different materials will contain different amounts of bitumen, and consequently different amounts of cement must be used in order to produce a certain amount of bitumen in the pavement, and this is generally stipulated in the specifications. This amount varies from 9.5 to 12.5 per cent., according to general conditions.

In the construction of an asphalt pavement there are two points upon which the practice does not seem to be uniform in the different cities. One is the treatment of the gutter and the other the area adjacent to the street car tracks. Many cities lay a gutter of brick, or stone. While there is no question that a stone or brick gutter is more durable than one of asphalt, it has generally been the practice in the borough of Brooklyn to lay the asphalt up to the curb; in no case has the cost of repairing the pavement in the gutter exceeded the average on the street surface enough to make it necessary to lay the more permanent gutter. The same difference in practice applies to the treatment of the area adjacent to the rails of the street car track, and here the Brooklyn practice has been to lay the asphalt up to the rails themselves without any intervening material. If the tracks are laid in the most approved modern way there is no objection to laying the asphalt up to the rails. On a railroad street the best possible construction, where asphalt is to be used, is to lay the asphalt from the curb to the tracks and pave the remainder of the street with brick, wood or smooth stone blocks. With a modern grooved rail and proper construction pavement can be so laid that traffic will pass across

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Consulting Engineer to the Borough President of Brooklyn, New York.

the tracks from one side to the other with no appreciable interference.

Maintenance and Repair.—In Brooklyn a municipal plant has been in use for five years, and the cost of repairing all of its asphalt streets out of guarantee has been 3.68 cents per square yard per year. As an indication of the effect of street car tracks upon the wear and tear of pavements, it should be noted that in 1911, in Brooklyn, the cost on street car track streets was 6.5 cents per square yard, while on streets without car tracks it was but 2.9 cents. In Buffalo, where probably a larger amount of asphalt has been kept in repair than in any other city, the cost for maintaining 43,000,000 square yards, scattered over a term of years, has been 3.78 cents per square yard. In this city the repairing is done by contract, the contractor being paid a unit price per square yard for work actually performed. In Toronto, Canada, repairs made with the municipal plant cost 77 cents per square yard of pavement actually laid, while in Detroit, which also used a municipal plant, the work cost $1.06 per square yard during the past eight years.

Life of an Asphalt Pavement.—In a careful analysis of the results of the work in Buffalo for many years Mr. H. Norton, deputy engineer-commissioner, deduces that the average life is 20 years. Officials of the city of Washington also estimate the life to be 20 years under ordinary conditions. The writer has generally taken the life to be 18 years.

In studying this subject during the past season the writer obtained from the cities of Buffalo, Rochester, Washington and the borough of Brooklyn, New York City, the cost of keeping their different pavements in repair for the successive years out of guarantee, the rule being applied to those pavements where the guarantee had been for five years. The costs in Washington have been applied to streets that have been laid 33 years. For the first year out of guarantee the pavement cost 2 cents, for the second year about the same, running up to a little over 4 cents the third year, gradually increasing to a little over 5 cents in the eighth, then decreasing to 4 cents in the eleventh, and running in a fairly uniform line to the nineteenth, when they reached 6 cents, and then gradually reducing to 2 cents in the twenty-eighth year. These figures refer to a large number of streets, except in the streets that have been out of guarantee more than 23 years. The strange thing is that the cost has been not more than 6 cents for any one year, and after the nineteenth year becomes less.

The records in Rochester have been kept for pavements 27 years old, in Buffalo 25 years old, and in Brooklyn 15 years old. These costs on the whole are about the same and fairly consistent with themselves, the Rochester costs being slightly less and Brooklyn slightly more than those for Buffalo.

Asphalt Block Pavement.—When asphalt blocks were first used they were made 4 in. wide, 5 in. deep and 12 in. long, but the thickness has been gradually reduced until at the present time the usual thickness is 3 in., and in some instances 2 in. for light traffic streets. The specifications which are now in use in Brooklyn, and which are probably as definite as any in the country, provide that the stone shall be trap rock as nearly cubical as possible, of a size to pass a ¼-in. sieve not less than 40 per cent. to be retained on a 20-mesh sieve and not less than 12 per cent. to pass a 100-mesh sieve. If the stone as received does not have this amount of fine material, dust is added to make the desired quantity, and in any case not less than 6 per cent. of dust shall be added. The blocks shall contain not less than 5¾ nor more than 8 per cent. of bitumen; the specific gravity of the blocks to be not less than 2.5. It is further provided that after being dried for 24 hours at a temperature of 150 deg. Fahr., the blocks shall not absorb more than 1 per cent. of water when immersed for seven days.

In bitulithic pavement the binding material is either asphalt or coal tar. The pavement is patented and it was originally intended to use coal tar, but asphalt has since been substituted to a greater or less extent. The principal idea is that the voids in the stone should be as small as possible, the materials being predetermined and apportioned by weight by elaborate machinery. The maximum size of stone used is approximately 1 in. in diameter, and on this account the pavement can be laid on steeper grades than the sheet asphalt. The first pavement of this character was laid in Pawtucket, R.I., on a 7½ per cent. grade, and the engineer of that city says that no trouble whatever has been caused by slipperiness. Up to February, 1912, about 20,000,000 sq. yd. of this pavement had been laid in this country.

ROAD BUILDING AT A MILE-PER-DAY RATE.*

By C. Howland Leavitt.†

During the last four months 102 miles of highways in the borough of Queens, New York City, have been resurfaced at an average rate of 10,000 sq. yd. daily or practically 1 mile per day. The work has been done under contracts involving a total expenditure of $1,877,820.

The old macadam roads generally had good foundations, many of them, in fact, having a Telford bottom, and with few exceptions the grades are light and the drainage good, the sub-soil being sandy. In a few instances the grades ran between 5 and 8 per cent., and these sections received special attention.

The controlling features in deciding upon the character of paving to be used were: The nature of the traffic, the construction then in place which was to be used to best advantage, the first cost and the cost of maintenance. Probably 75 per cent. of the traffic is automobile. This portion of the traffic demanded a smooth pavement and one that could be kept in smooth condition continuously. The heavy horse-drawn traffic demanded a surface affording a good foothold and easy draft. For heavy grades the choice was granite block. Generally a bitulithic carpet placed upon the old macadam seemed best to meet all requirements. The first cost of a bitulithic macadam by the penetration method would have been considerably lower than a bitulithic concrete by the mixed method. Under the traffic to which these loads are subjected a light flush coat of bitumen and stone at a cost of from 10 to 15 cents. per square yard would be necessary yearly to maintain bitulithic macadam in good condition. Experience has demonstrated to us that such is the case. Adding this to first cost, as determined by actual contract cost, would bring the cost at the end of five years to about $1.25 per square yard for bitulithic macadam. We estimated that a bitulithic concrete on a properly prepared macadam foundation, including the preparation of the foundation and 5 years' guarantee, would not exceed this. The low bids as received have varied generally from $1 to $1.20 and the average for 1,396,550 sq. yd. was $1.11, including a five years' maintenance.

Owing to differences in the length of haul for materials used and also in the varying requirements as to gutters, binders, etc., the price bid varied in the different contracts. In the case of the Hoffman Boulevard, a street of unusually

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Superintendent, Bureau of Highways, Borough of Queens, New York City.

heavy traffic, the price ran as high as $1.44 per square yard, while on the other hand there were a number of cases in which prices ran below $1, going as low as 86 to 91 cents in several cases.

The essential features of these specifications for a bitulithic concrete wearing surface are the requirements for the asphalt, mineral aggregate, the method of preparing the old macadam foundation and the laying of the asphaltic concrete. A high grade of asphalt was specified and materials from five different sources were used by the various contractors. About three-fourths of the entire amount used, however, was Bermudez asphalt.

The old macadam road was as lightly scarified as would permit of the reshaping of the old road to the crown desired. After shaping with rakes and forks it was then rolled and filled, additional stone being added where necessary, until the foundation was tight and compacted, to a width 1 ft. wider than the finished pavement; 2-in. planks were then drift-bolted to the foundation along the lines to which the asphalt was to be laid and the asphalt spread and raked. In rolling the rear roll was run over these planks so as to grip them, and in this way good compression was obtained on the edges; neat cement was cast over the surface after the preliminary rolling and swept with a broom so as to fill in the small voids in the surface and the rolling continued to final compression. After the removal of the planks the macadam along the edges was partly removed and bricks, generally in three courses, laid along the edge and filled with a bitulithic filler. In some instances the bricks were omitted and broken stone was used along the edges filled with screenings and thoroughly rolled in. The latter method seems to prove satisfactory where the travel is not crowded so as to compel vehicles to run along the edge of the pavement constantly. The wings of the roads were then graded to a gutter line generally from 5 to 7 ft. from the edge of the pavement.

Although the seepage into the subsoil is good, there were places where water would collect, and we took special pains to drain these places by building small basins with drains to carry off the water. Stone gutters were used wherever it was deemed advisable to prevent wash.

This work was distributed over an area of 65,000 acres, and was divided into 57 contracts. The greatest length covered by a single contract was 6.2 miles, the shortest 0.47 mile. In every case the contracts were allotted to the lowest bidder. All the asphaltic concrete contracts were identical as to form, and there was a single standard set of specifications throughout, which, however, provided sufficient elasticity to be adaptable to any conditions of the old roads.

Portable plants of several different types, all working on the same principle as the permanent asphalt plants, were used, in addition to three permanent asphalt plants. The Continental Public Works Company used a semi-portable plant, consisting of high-speed engine and locomotive boiler; sand-heating devices consisting of an American process driver 30 ft. long, 4 ft. in diameter, jacketed with asbestos and equipped with a Dutch oven with fuel oil burner attachments; a mixing unit consisting of an inclosed hot sand bucket-elevator, sand screens, sand hoppers with the necessary bins for the separation of the mineral aggregate, measuring boxes and a 6-ft. asphalt mixer. The usual asphalt kettles of about 1,000 gal. capacity were used. In this particular plant fuel oil was used both in the heating drum and in the boiler with excellent results. This plant had a maximum capacity of about 1,500 sq. yd. of 2-in. asphalt concrete per 8-hour working day.

The Barber Asphalt Paving Company on a portion of its work used a semi-portable plant very much of the same type as the one above described. This plant, as well as several others, was equipped with the necessary compressed air fixtures to convey the asphaltic cement from the tanks directly to the mixing platform. This plant would prepare and mix enough bituminous macadam mixture to lay 1,200 sq. yd. 2 in. thick in 8 hours' operation. The other plant used by this company was a permanent asphalt plant with a capacity of about 3,400 sq. yd.

The Cleveland Trinidad Company put up a permanent plant on the waterfront. This plant has a capacity of about 3,000 sq. yd. of 2-in. asphaltic concrete per working day of 8 hours. This plant was equipped with a compressed air purveyor for the asphaltic cement.

J. F. Hill used two Cummer railroad plants, each having a rated capacity of 2,000 sq. yd. These plants are mounted on railroad trucks and so constructed that they can be dismantled and made to travel on their own wheels when in transit. They are provided with horizontal revolving drums mounted over a fire box and surrounded with a fire-proof arch through which the mineral aggregate is fed. These plants weigh about 90 tons each and they have their melting kettles, mixing apparatus, boilers, engines and shafts so arranged as to enable one to readily prepare them for transit or for operation after transit. This company carried a fully equipped laboratory and employed experienced chemists at the plant to supervise tests and analyze its mixes and pavements.

The Standard Bitulithic Company used six portable asphalt plants of the Warren type in carrying out its portion of the work. One of the main favorable features of these plants is the fact that they can be put in operation in new locations in a few hours; although simple in their construction, they are so arranged that there is no guesswork as to the proportions of the ingredients, but every step and every portion is under direct control of the operator.

There were fourteen plants engaged on this work during the season, and the main features of the others were similar to those above outlined, or a combination of the same. There was one plant used by the Newton Paving Company, known as the Equitable asphalt plant. This plant differed from all the rest in that the mineral aggregate was put directly into the mixing drum and heated by a hot air blower and then the asphaltic cement was supplied by an air compressor directly from a measuring tank, the stone dust added and the heating and mixing continued until the proper temperature was reached. This plant weighed 36 tons and can be moved readily. It worked very satisfactorily and had an average capacity of 1,000 sq. yd. of 2-in. asphaltic concrete in an 8-hour run; in some instances this amount was exceeded by several hundred yards.

The Borough Asphalt Company mixed its material in a permanent plant located on Newtown Creek, Brooklyn; the capacity is 4,000 sq. yd. of 2-in. material in a run of 8 hours. This plant is probably as complete and well arranged as there is to be found, it being practically dustless when in full operation, and after the first elevation of the material the whole operation is by gravity. All material is under cover and kept from the weather from the time it is unloaded from the scows until it is sent out as a finished product.

The Uvalde Asphalt Company carried out its work from a permanent plant of the usual type located on Newtown Creek in Brooklyn. This plant was located from 6 to 12 miles distant from the site of the work; the material was brought in trolley freight cars to a switch near the work, from which it was then trucked to the street, and in some instances where a trolley track was on the street the material was shoveled directly from the cars into the place to be paved. This plant has a capacity of 4,000 sq. yd. of 2-in. material in an 8-hour working day, and their highest run for a single day of 8 hours was 3,500 sq. yd.

THE PURCHASE OF LIME FOR WATER PURIFICATION.*

By W. F. Monfort.

Lime for water treatment is valuable in proportion to its percentage of water-soluable calcium oxide; but its value is diminished disproportionately by the presence of inert materials natural to the stone—magnesia, alumina, silica—and unburnt stone, although for other purposes these materials may be nearly harmless if not positively beneficial. Hydrated lime has been used by numerous railroad and commercial softening plants and in some smaller cities, but its relatively high cost, the difficulty of feeding it in a large way, and the abundance of dust liberated in handling it have limited its application. In most of the larger plants quicklime is used. The present discussion relates to the vagaries of specifications for the purchase of this latter material.

A contract based solely upon the percentage of lime in deliveries is unjust to the purchaser, in that he pays at contract rate for calcium oxide, however much stone and other impurities are contained. The vendor sells whatever he happens to have; the purchaser receives what he must, without recourse for expense of unloading, crushing, storing, and using a considerable proportion of inert material, which clogs slaking tanks, involves waste of power in stirring, and necessitates more frequent cleaning of tanks. That this expense is not inconsiderable is evident from the following illustration. Between cleanings 253 tons of lime averaging 90 per cent. were slaked at times last year at St. Louis when half the lime used was low in inert matter, against an average of 171 to 175 tons of 83 per cent. lime during the remainder of the year. The accumulation of pieces of core and rubbish from 105 tons of lime caused stoppage of a 10-h.p. motor. The cost of cleaning a tank and starting a new one is approximately 5c. per ton greater with an 83 per cent. lime than with a 90 per cent., not counting the waste of power in stirring. It is obvious that some system of penalizing for impurities should be enforced.

The impossibility of procuring a commercial lime containing 100 per cent. water-soluble calcium oxide influences most purchasers to write specifications upon the basis of a lower guarantee content. In some cases this has resulted in confusion in adjustment of purchase price for better and poorer limes, with purely nominal and misleading bonus and penalty clauses.

If the vendor is to receive full payment for pure lime delivered, with neither bonus nor penalty, the increment is, of course, found by the general formula: 100 guaranteed per cent. = per cent. of contract price to be added or subtracted for each 1 per cent. variation from the guarantee. (See Table I.).

Table I.—Increment for Various Guaranteed Percentages of Lime.

(Without bonus or penalty).

Guarantee.	Increment.	
50%	2.00	of contract price
60	1.666	
70	1.428	
80	1.25	
85	1.176	
90	1.111	
95	1.052	
100	1.00	

Considering a contract based upon a guarantee of 90 per cent. CaO, any bonus or penalty paid or exacted must be by an increment greater than 1.11 per cent. of the contract price; so that, for example, a nominal bonus and penalty of plus or minus 1.5 per cent. of contract price is equivalent to an actual penalty or bonus of 1.5 less 1.11, or 0.39 per cent. of the contract price for each 1 per cent. variation from 90. A nominal bonus of ½ per cent. would be an actual penalty on any basis of percentage guarantee; a nominal penalty of 1 per cent. of contract for each 1 per cent. deviation in percentage of lime delivered below that guaranteed would be an actual bonus on any basis of guarantee other than 100 per cent. CaO.

In considering the fairness of specifications for lime it is expedient to calculate the purchase price per ton as delivered, and the cost per ton of pure lime to the user, as representing the working of the contract from the viewpoint of vendor and purchaser, respectively. By way of illustration, Table II. gives an analysis of some contracts proposed or operative in connection with waterworks plants.

Table II.—Data on Various Lime Contracts.

		A	B	C	E	F
Contract price		$4.23	$4.23	$4.70	$4.23	$3.925
Guarantee		90-95%	90%	100%	90%	85%
Nominal bonus		0.5%	1.11%	.....	1.5%	1.5%
Nominal penalty		1.0%	1.11%	1.0%	1.5%	1.5%
Purchase price.						
Delivery	100%	$4.33	$4.699	$4.70	$4.685	$4.808
	95	4.23	4.46	4.46	4.547	4.513
	90	4.23	4.23	4.23	4.23	4.219
	85	4.018	3.995	3.995	3.914	3.925
	80	3.81	3.76	3.76	3.59	3.62
	75	3.59	3.52	3.52	3.278	3.336
	70	3.28	3.29	3.29	2.96	3.042
	65	3.17	3.05	3.05	2.644	2.747
	60	2.96	2.82	2.82	2.333	2.453
Cost per Ton CaO.						
Delivery	100%	4.33	4.695	4.70	4.865	4.808
	95	4.452	4.70	4.70	4.786	4.751
	90	4.70	4.70	4.70	4.70	4.683
	85	4.727	4.70	4.70	4.604	4.618
	80	4.759	4.70	4.70	4.449	4.526
	75	4.794	4.70	4.70	4.370	4.449
	70	4.83	4.70	4.70	4.23	4.345
	65	4.88	4.70	4 70	4.061	4.226
	60	4.93	4.70	4.70	3.88	4.088

Per Cent. of Contract Price to Give Purchase Price.

Delivery	100%	102.5%	111.1%	100%	115%	122.5%
	95	100	110	95	107.5	115
	90	100	100	90	100	107.5
	85	95	94.44	85	92.5	100
	80	90	88.88	80	85	92.5
	75	85	83.33	75	77.5	85
	70	80	77.77	70	70	77.5
	65	75	72.22	65	62.5	70
	60	70	66.66	60	55	62.5

Contract A is unjust to the seller, in that the contract price obtains for any lime delivered which falls within the limits of 90 to 95 per cent. The framers of these specifications intended to be kind in this clause; but the guarantee is actually raised to 95 per cent. for good lime, and lowered to 90 per cent for bad, with no discrimination in what is really the highest range of commercial limes.

The increment of 0.5 per cent. above 95 per cent. is a bonus only in name, as has been shown; the vendor receives

---

* A paper presented to the American Public Health Association, Washington, D.C., and to the Central States Water Works Association, Detroit, Mich., September, 1912.

a trifle more for a 96 per cent. than for a 95 per cent. lime; but the increment is 0.61 per cent. less than the normal increment for a 90 per cent basis (1.111 per cent.), and therefore an actual penalty is placed upon deliveries better than the guarantee. The deduction of 1 per cent. instead of 1.11 for each 1 per cent. below the guarantee leaves an actual bonus of 0.11 per cent. operative. Stated in another way, the actual penalty is put upon the delivery of good lime in that, instead of receiving 111.11 per cent. of the contract price for 100 per cent. lime, as under a contract on a percentage basis, the seller is paid under a supposed bonus clause only 102.5 per cent. of the contract price, while the purchase price on deliveries of 90 per cent. or less is always 10 per cent. of contract price above the per cent. CaO delivered.

From the standpoint of the user, the cost of pure lime is $4.70 in a 90 per cent. delivery; $4.427 in 100 per cent. delivery; $8.46 in a 10 per cent. delivery; $44.63 in a 1 per cent. delivery; whereas unburnt stone at a purchase price of 43c. per ton would afford a ton of pure lime at an infinite cost.

The vendor receives no bonus and has no incentive to furnish good lime; but, since this contract imposes no penalty for poor lime, he has every reason to send the maximum proportion of unburnt stone which will be accepted. The purchaser pays more for poor lime than for good, and suffers further losses entailed by unloading, crushing, using and removing from his tanks this obstructing material. The facts are manifest in the accompanying table and diagrams.

Contracts B and C, though differently worded, yield the same figures for cost of pure lime and for purchase price without bonus and penalty, and give normals for establishing the value of increments in other specifications.

Contract E gives a bonus and exacts a penalty of 0.39 per cent. of the contract price for each 1 per cent. deviation from the guarantee. The vendor, therefore, receives some compensation for care and labor in preparing a well burnt lime; the purchaser is safeguarded to some extent against loss in refuse material. It is probable that a larger increment would result in greater economy to the purchaser, by securing a lime of higher calcium-oxide content and reducing the power cost.

Contract F is now operative at St. Louis, in lieu of Contract A, which was in effect last year. The contract price ($3.925 per ton for 85 per cent. lime) is the average of two lettings to the same contractor. The increment 1.5 per cent. leaves a net bonus and penalty of 0.324 per cent. of contract price, which is again too small, if the advantage of good lime to the department is considered. In the Table III. comparison is made of cost of calcium oxide and of purchase price for contracts A, B and F throughout the range of percentages in deliveries for June-August, 1912.

Table III.—Comparison of Workings of Lime Contracts—1912 Deliveries.

		Per Cent. Delivered.				
Cost CaO		90	85	80	75	70
Contract	A	$4.70	$4.727	$4.750	$4.704	$4.83
	B	4.70	4.70	4.70	4.70	4.70
	F	4.683	4.618	4.526	4.449	4.345
Purchase price						
	A	$4.23*	$4.018	$3.81	$3.50	$3.38
	B	4.23*	3.99	3.76	3.52	3.29
	F	4.22	3.925*	3.62	3.34	3.04

* Contract price.

The average of available lime for eight summer weeks was 85 per cent. on 1,050 gross tons delivered, or 1,572 tons of pure calcium oxide therein contained. Cost per ton of pure lime and purchase price fall below last year's figures by about 10c. per ton for this particular percentage.

In two cities a form of contract is used which gives a bonus and penalty of so many cents per ton for each 1 per cent. departure from the guarantee. Whether this results in payment for lime on a percentage basis; in a bonus for good and a penalty for worse lime, or in a bonus for bad lime and a penalty for better, depends upon the contract price, since the value of the increment with respect to the contract price is a variable quantity. One current contract gives a bonus of 7c. per ton for each 1 per cent. above, and deducts the same amount for variations below the guarantee (88 per cent.). Older specifications gave a bonus and penalty similarly of 14c. per ton on the same guaranteed percentage. Analyses of these specifications on the lines of the foregoing discussion give the results shown in Table IV. (The normal increment for an 88 per cent. lime is 1.13636 per cent. of contract price).

Table IV.—Comparison of Increments, Bonus and Penalty of Lime Purchases.

(Contract Price Assumed at Various Values; Percentage Guarantee, 88 per cent.)

	Nominal Bonus—14c. per ton.		7c. per ton.	
Contract price.	Increment.	Bonus and penalty, actual.	Increment.	Bonus and penalty, actual.
$12.32	1.13636%	0.0 %		
11.00	1.153	0.01636		
10.00	1.168	0.03164	1.084%	0.05236
9.00	1.1866	0.05024	1.09	0.04636
8.00	1.21	0.07364	1.105	0.03136
7.00	1.24	0.10364	1.12	0.01636
6.20	......	....	1.13548	0.000878
6.00	1.28	0.14364	1.14	0.00364
5.00	1.336	0.1996	1.168	0.03164
4.00	1.42	0.2836	1.2	0.07364

Under the first specifications (14c. bonus and penalty) the increment is too small between $6 and $7 per ton, the probable range of prices in that district, with extinction of bonus and penalty at $12.32. Under the second specifications, extinction of bonus and penalty occurs at about $6.20 per ton, leaving above that price a penalty on better deliveries, and a bonus for poorer deliveries than are called for by contract. The amount of bonus is too small to be an incentive to keep the quality of lime delivered up to a desirable standard. In such case dependence must be placed upon some additional clause in specifications as a basis for rejection of unsuitable material.

The common practice in commercial analysis of returning as available the total calcium oxide soluble in hydrochloric acid renders it advisable to incorporate in the specifications a statement of the method of sampling, sample reduction, and of analysis. The scheme adopted in this laboratory follows: Lump lime in bulk is received in car lots and crushed to ¾ in. or less upon receipt. By means of a small pivoted chute at the outlet of the crusher small portions at 15-min. intervals are collected during the unloading of the car making a total sample of about 50 lb. per car. This is passed through a second crusher in order that no pieces exceed ½ in. in greatest dimension. A sample reducing machine described in Engineering News for November 23, 1911, is used to reduce the 50-lb. sample to about 2 lb., after which the entire small sample is pulverized to about 60 mesh in a Sturtevant pulverizer.

In the laboratory a Buskett mechanical riffle reduces the 2-lb. sample to about 14 grams. Approximately 7 grams (8 c.c.) of powdered sample is accurately weighed in a weighing tube, and emptied directly into a 1-liter volumetric flask containing 70 grams cane sugar dissolved in about 800 c.c. cold carbon dioxide free distilled water. Brisk rotation of the flask before introducing the weighed sample prevents caking. Flasks are shaken on a Camp machine 20 min., and allowed to stand over night. The solution is shaken, made up to the mark, mixed thoroughly and 200 c.c. are diluted to a liter, 100 c.c. of this dilution is titrated with tenth normal hydrochloric acid, using phonolptalein. The method is a modification of one commonly used in sugar-house practice (Croghan, C. A., 1908, p. 768).

Delivery of limes containing appreciable quantities of magnesia may be guarded against by a clause in specifications, and occasional analyses made. Limes of the St. Louis district commonly contain less than 1 per cent. magnesia.

Shippers are prone to consider deterioration in transit as working a hardship to them, although the lowered percentage of calcium oxide through absorption of moisture prior to weighing on receipt is balanced by increase in weight of car contents. The protection of the bulk of the car load by the layer of finely divided (air-slaked) lime has been long known. Further, our experience of the summer of 1912 with cars of well-burned lime covered with paper during transit indicates that serious deterioration may be avoided. Two cars shipped and received on the same dates showed the advantage of "overburning" in the meaning of the lime trade. One (ordinary run of kiln, containing some core, and covered with paper), was badly air-slaked, analyzing 76.7 per cent. calcium oxide soluble in sugar solution. The other (well burned—slightly overburned in the opinion of the kiln operator) covered with paper in transit, ran 90.8 per cent. calcium oxide. Fourteen cars of overburned lime in the summer months averaged 88 per cent. The degree of overburning was below that which would make trouble in drawing the kiln; sufficient, however, to greatly reduce the amount of core. The product slaked well. It is better described as well burned than as overburned lime.

Nevertheless, in our latest specifications a clause appears making an allowance from April to October of 2c. per ton for each 24-hour delay in unloading after a lapse of 48 hours from receipt on our tracks. The concession is larger than is equitable; it is, however, rarely operative.

The substance of this paper was put into the hands of all bidders on our current contracts. It was given wider circulation in the hope of directing attention of both writers of specifications and bidders to some essential facts which have been overlooked in purchasing lime for water treatment.

Summary.—Specifications for purchase of lime should be based upon a single percentage guarantee.

Bonus and penalty clauses introduced to guard against loss incident to impurities should be in terms of percentage of contract price.

The increment should be sufficiently large to provide an actual bonus and penalty for variations in quality of lime delivered, and should be based upon the source and quality of lime available.

Instances are cited illustrating the injustice of specifications drawn without analysis of their workings.

Well burned lime ("overburned" of the trade) suffers slight deterioration in transit, especially if covered with paper.

Methods of sampling and of analysis should be described in specifications.

A GRAVEL WASHING PLANT.

The western coast of Canada is the scene of great building activity, which is the result, not of a boom, but of a healthy, though rapid, growth, and although this country is rich in its forests and lumber is plentiful, it is a noteworthy fact that quantities of brick and concrete are being used and the building is being done for the future. On account of the large amount of concrete construction, there is a great demand for sand and gravel and many gravel washing plants have been erected in this territory during the past year. It is also interesting to note that the usual source of sand and gravel in this territory is the river beds, and many of the plants of the western coast have been located on rivers and supplied by barges bringing in dredge excavations.

The plant of the Higgins-Fisher Company is located in Elburne, B.C., a small suburb of Vancouver. This plant is unique in serving a double purpose, enabling one business organization and one plant to serve for two businesses, which have alternate seasons of activity. During the building season the plant receives gravel from barges on the Fraser River, which it screens and crushes and stores in bunkers for supplying the market with concrete aggregate. In winter, coal is received in the same way and is screened and graded in the various bunkers and likewise drawn off to wagons for city delivery. In this way, the one plant serves the purpose of a coal pocket and a gravel screening plant with only an investment equal to that required for either purpose.

When rock or sand and gravel is unloaded from the barges, which is done by means of a grab bucket, it is dumped onto a grizzley, covering the main hopper. This grizzley is set at an angle of 60 degrees, inclined toward a No. 2 Gates gyratory crusher, and all material over 2½ inches in diameter, is rejected to this crusher. The material from the crusher is passed onto a 14-inch Stephens-Adamson belt conveyer, 93 feet centres, leading on an incline to a point above the crushed rock bins. Discharge to the bins is made through a revolving screen which sizes the material and distributes to two compartments.

The gravel, passing through the 2½-inch grating above the first hopper, passes down onto the main conveyer. This conveyer is 24 inches wide and 207 feet between centres; it rises on an incline to a point above the main bunkers and then breaks over a snub pulley and runs horizontally to the farther side of the building. This horizontal run of the conveyer is equipped with an automatic tripper which may discharge to any one of the bunkers, or into a revolving screen, which washes the gravel and separates it into three sizes, namely, 2¾, 1¼ and ¼-inch.

When coal is handled in the winter months, the grizzley is removed from the hopper and the small conveyer and crusher are disconnected by means of steel plate friction clutches, which control the drivers. Coal is then delivered to the main conveyer and distributed over the tripper, directly to the bunkers or through the screen. Coal may then be drawn off through the gates in the bottom of the bunkers. The capacity of the main bunker is approximately 1,000 yards and the small ones hold 150 yards. The drive for the plant is from an electric motor, located at the head end of the main conveyer, and the short conveyer and screens are driven through rope drives from this conveyer countershaft. The crusher is driven from the extended countershaft of the tail pulley of the main conveyer.

Another feature of this plant, and one unusual in most gravel plants, is a car puller, which is used for spotting the cars on the track beside the bins. This car puller makes it a very simple matter for one man to handle a small string of

cars without the use of a locomotive and in considerably less time than is required when using hand car-movers. This car puller is driven from the motor at the head of the main conveyer and the operator uses it simply by winding the rope about the capstan and keeping the rope taut. This produces sufficient friction between the rope and the capstan to move five loaded cars.

This plant was completely designed and equipped by the Stephens-Adamson Company. Both conveyers operate on unit ball bearing carriers, and provision is thus made for a later increase in capacity as well as cutting down the power requirements.

WOOD BLOCK PAVEMENT LAID BY CITY LABOR. *

By Ellis R. Dutton.†

The city of Minneapolis has at the present time over 1,000,000 sq. yd. of creosoted wood paving, laid by day labor. In 1901, the city officials began as investigation of paving materials. Sheet asphalt, laid by contract under a guarantee, was not kept in repair by the company; brick paving was noisy and sandstone blocks wore badly. In 1902, the city council ordered one of the streets to be paved with creosoted wood blocks similar to those used on Michigan Boulevard in Chicago. The blocks were 4-in. southern yellow pine, treated with 12 lb. of Kreodone oil. There were laid 13,500 sq. yd. at a cost of $2.79 per square yard, the city doing all the work by day labor and purchasing the blocks from the Republic Creosoting Company at $1.95 per square yard f.o.b. Minneapolis. These blocks were laid at an angle of 62 deg. with the curb upon a 6-in. natural cement concrete foundation over which was spread a 1-in. cushion of sand. There were no transverse expansion joints but a 1-in. longitudinal joint was made on each side of the street parallel with the curb. These joints as well as the joints between the blocks were filled with paving pitch, and the street was finished with a ¼-in. coating of sand to absorb the excess pitch on top of the blocks. It was considered better practice to lay them at an angle with the curb, instead of at right angles, both on account of the travel and also the expansion; the correctness of this assumption has been proved by experience. The wear up to the present has been only ⅛ in.

Norway and Yellow Pine.—Since Minneapolis is situated in a pine country the use of Norway pine for paving blocks was suggested. Accordingly, arrangements were made for the erection of a treating plant in Minneapolis, if the city would use 30,000 sq. yd. of creosoted Norway pine blocks. The price of this class of blocks was $1.64 per square yard f.o.b. Minneapolis, using 12 lb. of Kreodone oil per cubic foot. In the paving of Third Avenue South in 1903 there were left over from 1902 about 300 sq. yd. of the yellow pine blocks which were used in this street, and the remainder was Norway pine. Samples of these two classes of wood, which had received exactly the same travel and wear, were taken from the street in 1911. The yellow pine blocks showed a wear of ⅛ in. and the Norway pine blocks twice as much. This was an actual comparative test of the two kinds of wood on the same street and under the same conditions.

In 1904 the price for blocks was $1.73 per square yard f.o.b. Minneapolis, but there were proposals as low as $1.51 per square yard, using common commercial creosote oil. The engineers and the paving committee considered the highest blocks treated with the best grade of oil to be the better and cheaper. It was believed that the oil that contained the larger per cent. of residue after distillation to 315 deg. C. was the better. The cheaper oil showed 43 per cent of residue, and the best showed 70 per cent. of residue, and this was the oil used. The wisdom of the purchase has developed by the experience. One piece of work that was done in another city using the cheaper oil never was satisfactory, and has been replaced some time ago with a better grade of paving blocks

Specifications for Oil.—The specifications of 1905 required an oil of a gravity of 1.09 at 20 deg. C. and specified the fractional distillation percentages. These were the first specifications of the kind and they have been followed throughout the country ever since. There is no class of paving that requires rigid inspection more than the creosoted blocks, and if it is possible to obtain a competent person to do the inspecting it is money well spent.

The required amount of oil per cubic foot was raised to 16 lb. this year, as it was considered better to fill the wood more thoroughly and make the blocks more waterproof. This amount has not been changed since, though other cities have put in 20 lb. or more, which I think has caused other trouble. The price of the blocks was $1.49 per square yard f.o.b. Minneapolis for 4-in. Norway pine.

We continued the use of Norway pine tamarac and hemlock until 1911, when we returned to yellow pine blocks which seemed to give the best results, especially on heavy traveled streets. We also used a 3½-in. block on the lighter traffic streets. We have had no trouble with our creosoted block pavements though on one particularly heavy traveled street the Norway pine blocks have worn about 2 in. and will soon have to be relaid.

Cost of Wood Block Pavement.—On January 1, 1912, we had a total of 968,000 square yards of creosoted wood block paving, put in at a cost of $2,466,000, or an average cost of $2.52 per square yard. The prices have varied, as the prices of material varied, from $2.29 in 1908 to $2.82 per square yard in 1907. The price of crushed limestone used in the concrete base averages about $1.75 per cubic yard delivered on the street. The sand costs about 75 cents per cubic yard, and Portland cement has cost from $0.865 to $1.80 per barrel delivered f.o.b. Minneapolis, depending on the year. This cost of paving, as given above, includes the grading for the foundation, the laying of the concrete base, the paving blocks, pitch and all the labor connected with making a complete paving. I have not heard of a city that gets as much for the money as we do. The city of Minneapolis does all of its public work by day labor and has done so for the past 12 years, with the exception of asphalt paving, which it could not do as it had no asphalt plant. The wages paid common labor in paving work has increased from $1.75 per day of 10 hours to $2.40 per day of eight hours in 1912. The skilled labor and teams have increased almost as much in proportion.

To show the preference from the different classes of paving from 1902 to 1912, the following table is given:

Types of Pavement in Minneapolis.

Kind of Pavement.	Sq. Yd. Jan 1, 1912.	Sq. Yd. Jan. 1, 1902.	Increase.
Sheet asphalt	164,441	206,471	*42,030
Brick	390,869	171,144	219,725
Creosote blocks	967,616	....	967,616
Granite blocks	403,915	156,994	246,921
Sandstone blocks ...	347,939	61,661	286,278
Macadam	335,159	129,305	205,854

* Decrease.

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Assistant City Engineer, Minneapolis.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD
MARINE AND MINING ENGINEER, THE SURVEYOR,
THE MANUFACTURER, AND THE
CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., MANAGING EDITOR
A. E. JENNINGS, ADVERTISING MANAGER
P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1 75 (7s.)	$1 00 (4s.)

Copies Antedating This Issue by More Than One Month, 26 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JANUARY 2, 1913. No. 1

CONTENTS OF THIS ISSUE.

ENGINEERING OUTLOOK FOR 1913.

Last year was a period of extensive development throughout Canada. A great deal of construction work of a private nature and for the municipalities and federal and provincial governments was completed. Probably the total cost of the work done totalled more than any previous year in the history of the country.

The indications for 1913 are exceedingly bright, and it is very likely that the total amount of construction work of a public and private nature will far surpass last year; particularly in the West, the towns and cities are increasing in population at so fast a rate that during 1913 it will be very difficult to keep pace with the demand for pavements, sidewalks, water supply, sewerage systems and transportation in general.

A digest of the projected work under the heading of "Engineering Outlook for 1913" will be found on another page of this issue. Its perusal will give some idea of what a few of the municipalities intend doing. These figures are all based on the present financial situation. If the market for municipal debentures improves, however, and it is altogether likely that it will, the amount shown under the different headings will be greatly increased.

It is expected that the public works estimates will total nearly $40,000,000, which will make provision for the works now under contract and for the new ones in view. Last year's total was a little over $30,000,000. It is altogether probable that a vote will be included for the Georgian Bay Canal; probably about $3,000,000. There will be also an additional appropriation for the Welland Canal construction. The Government have signified their intention of co-operating with the Toronto Harbor Commission improvement, which was outlined in these columns some weeks ago, to the extent of $6,000,000. Only a part of this, however, will be voted this session.

Toronto will also secure appropriations for the proposed Federal Square of a half million dollars, and also for progress work on the Toronto barracks. A million and a half will be given to Ottawa for new departmental buildings, and a large amount of money will be spent on the Montreal harbor improvements.

The big appropriations will be for a continuance of extensive harbor works at Victoria, B.C., Toronto, Quebec and St. John, and for the new Intercolonial Railway terminals at Halifax. Tenders have just been called for the two million dollars improvements at the St. Charles River, Quebec, involving the construction of a dam and two locks. Another work for which proposals are being asked is that of improving the river in Pictou to make it navigable. The improvements will greatly add to shipping facilities for the Nova Scotia Steel and the industries. Besides the above, the estimates will make provision for many public buildings, such as post-offices and custom houses at the smaller centres throughout the country.

In connection with the announcement that the Winnipeg-Cochrane section of the Transcontinental Railway is to be opened for grain traffic next week, the total expenditure to the end of the fiscal year was $116,000,000, of which $21,000,000 was spent in the year 1911-12. The total for completion of the work will be around $140,000,000.

REINFORCED CONCRETE AND FORMULÆ.

In view of the diverse opinions from time to time expressed regarding the strength and stability of reinforced concrete structures it is desirable that engineers and architects should determine at what point there is divergence from the common ground of agreement, and in what manner experience with such structures, and the advance of theory respecting design, can be made to dispel the present misunderstandings. The London "Times" states that so long as there is controversy between experts there must necessarily be doubt in the minds of the public, and this attitude will properly be reflected in the restraining laws and ordinances of boards and councils. When the various commercial interests concerned are considered and weighed it becomes obvious that the task of collecting positive evidence must be attended task of collecting positive evidence must be attended with difficulty. Nevertheless, a great amount of work is being done to improve knowledge of the preparation and behaviour of concrete, and contributions to the theory of reinforcement are numerous. Why, then, should the disputings be so prolonged and at times so acrimonious? The answer surely is that it is a war arising largely from terms requiring definition and centring upon a substance which itself is indefinite. Too often equations relating ta perfectly elastic, homogeneous isotropic solids are made to do service for aeolotropic portions of matter, but when such equations are requisitioned for the purpose of solving problems relating to the stresses and strains in sandwiches of steel and concrete, the result is necessarily disquieting. What, for example, is the meaning of the modulus of elasticity in such circumstances? Even in comparatively homogeneous solids this modulus has only a courtesy title to be a constant—it is far more likely to be a logarithmic function of the displacement—and its use as a constant in formulæ relating to reinforced concrete should be either amended or discountenanced. The line of agreement must follow closely the line of direct observation and practical tests on standard sections and frames, followed by makers' guarantees, but considerable assistance would be derived from a friendly conference upon nomenclature and formulæ.

ROADS IN SASKATCHEWAN.

The report of the Highway Commissioners for the current year up to October 31 has been brought into the Saskatchewan Legislature recently. By order-in-council of April 25, 1912, the sum of $1,500,000 was appropriated for expenditures in the construction and improvement of highways, and an additional sum of $100,000 for steel bridges on concrete foundations. The sums were divided by the Commissioners into two amounts, $1,300,000 for highways, and $300,000 for bridges. In the report of expenditures, $663,233.17 is shown, as the total expended on road improvement direct; $56,723.70 expended by municipalities, and $47,923.79 expended on roads under regulations. That is jointly with municipalities. When miscellaneous expenses are added, the total sum expended on road account by the commissioners and municipalities during the period covered by the report is $9;8,070.19.

Provision was made, the commissioners state, for undertaking permanent bridge work to the extent of $300,000. Contracts are under way or entered into that will absorb the whole of the $300,000, but up to October 31 the expenditure did not amount to $100,000.

ENGINEERING OUTLOOK FOR 1913.

The coming year will probably surpass all previous ones in the total amount of municipal construction work to be done. The present plans of a number of the towns and cities throughout Canada, as outlined in the following, will give some idea of the general trend of engineering work throughout the Dominion. The figures as given are in all cases on the conservative side. If the present financial situation improves and the municipalities are able to secure a ready sale for their debentures, the amount of work will be very greatly increased. The country is developing so fast, especially in the West, that the towns and cities will find it exceedingly difficult to provide the necessary accommodation in the way of pavements, sidewalks, water supply, sewerage system and transportation.

Sydney, N.S.—There is no large work in prospect in this city. There will be the usual sewer and water extensions, street and sidewalk work. Estimates are being prepared for a large extension to the waterworks system, but the work will hardly be reached in 1913. City engineer, D. M. Campbell.

Halifax, N.S.—The city expect to construct a 3,000,000-gal. concrete reservoir for the high service water supply system, at an estimated cost of $40,000. Extensive changes to the water distribution system, estimated cost $60,000. The construction of an intercepting sewer along the shore of the northwest arm of the harbor, approximate cost, $100,000. Concrete sidewalk construction, $50,000. Sewer extension, $50,000. City has under construction a garbage incinerator to cost $46,000. The Acadia Sugar Refining Company are constructing a sugar refinery at a cost of about $500,000. The railway department will construct during the next year a terminal pier, total cost, $1,000,000. Contract for this work was made by the Laurier Government. The Dominion Government are making surveys and designs for a new terminal on the waterfront. Estimated cost, $15,000,000, of which the average expenditure will be $1,000,000 a year. The railway department has also under construction a line of railway from Halifax to Musquodoboit. City engineer, F. W. W. Doane.

Public Works Department, Halifax, N.S.—The Department of Public Works, of Canada, district engineer's office, Halifax, which comprises the counties of Halifax, Lunenburk, Hants and Colchester. The annual appropriation for dredging harbor improvements, breakwater, public wharves, etc., will be about $300,000, of which $100,000 is for dredging and the balance for construction. It is expected that a number of large works will be taken up this session and that the appropriations for this year will be larger than usual. District engineer, H. A. Russell.

Fredericton, N.B.—The city will carry on work to an amount upwards of $10,000 on concrete curbs and gutters, pavements, surface sewers; distribution water mains, and sewerage system extension. Some large contracts are contemplated also. City engineer, John O'Neill, B.Sc.

Toronto, Ont.—During 1912 there has been spent on local improvement work about $1,500,000; on storm overflow sewers, $350,000; trunk sewers, $2,000,000; the filtration plant has cost to date $700,000; and the new 36-inch main from the main pumping station to the reservoir, $120,000. In addition a 24-inch and 20-inch supply main was laid at a cost of $120,000. The mileage of pavements laid was 40 miles; the mileage of sidewalks, 52 miles. 2.7 miles of trunk sewer were completed, and there will be about one-half mile to complete next year. It is expected that work on the Crawford Street bridge, Gerrard Street bridge, Toronto Avenue bridge, and other bridges not including the Bloor Street viaduct, will be proceeded with during 1913. An estimated cost of this work

is about $550,000. The following money by-laws are being submitted to the ratepayers: $200,000 grant to the National Sanitarium Association for the fight against tuberculosis; $6,677,000 for a waterworks system at Scarboro' Bluffs; $1,375,000 for a new filtration plant and conduit; $2,500,000 for the Bloor Street viaduct; $1,000,000 for a modern garbage disposal plant; $954,000 for storm overflow sewers. Commissioner of Works, R. C. Harris.

London, Ont.—This city expects to do a good deal of work during 1913. Among other things, the construction of a complete storm water sewer scheme for the entire city is contemplated at an estimated cost of $985,000; a portion of the permanent breakwater on the west bank of the River Thames will be built at a probable cost of $30,000; a highway bridge over the River Thames will be erected at a cost of $30,000; also, the completion of an incinerator plant, capable of disposing of fifty tons of garbage per day; the laying out of a federal square, and construction of a new city hall at a cost of $250,000; the London and Port Stanley Railway, which is owned by the city, will probably be electrified at a cost of $900,000; approximately two miles each of permanent pavement, sidewalks, curb and gutter, and sanitary sewers will be constructed under the Local Improvement Section of the Municipal Act; a good deal of work will be done on the extension of the London Street Railway and the electric lighting of the recently annexed districts composed of Pottsburg, Knollwood Park, Chelsea Green, and Ealing. City engineer, H. A. Brazier.

Sudbury, Ont.—The building permits for 1912 totalled to nearly $550,000. Next year promises to be even greater than 1912. There are many new buildings to be erected; the Bell Telephone Company have called for tenders for a $40,000 building. The Bank of Ottawa will erect a large block, and a $25,000 fire hall will be built. There is a scarcity of contractors for this work as, although tenders were called for the three above some time ago, no tenders were received.

Steelton, Ont.—A waterworks by-law is to be submitted to the ratepayers in January for $50,000 for the installation of an intake pipe, pumping station, force main, standpipe, etc., and it will probably pass. There will be considerable concrete pavements laid, also concrete sidewalks. Some sewer extension work will be done, as well as extensions to the waterworks distribution system. It is expected that $100,000 will cover the amount to be spent in improvements in 1913. W. B. Redfern, town engineer.

Niagara Falls, Ont.—The city will probably spend $50,000 on permanent pavements; $10,000 on permanent walks; $10,000 on sanitary sewers; $25,000 on waterworks extensions. City engineer, J. C. Gardner, B.A.Sc.

County of Welland.—The county will probably spend $100,000 on macadam roadways. Road superintendent, J. C. Gardner, B.A.Sc.

Belleville, Ont.—The city expect to spend on the sewerage system for West Belleville, $250,000. Permanent roads, $75,000; concrete walks, $20,000; buildings, $400,000. Total, $745,000. City engineer, James G. Lindsay.

Welland, Ont.—There is a good year's work ahead in this town. It is expected that 15,000 sq. yds. of street paving will be laid at a cost of $50,000; about four miles of concrete walk, $13,000; 1.7 miles of sewers, 8-in. to 20-in., $25,000. The disposal plant and trunk sewer system will probably be commenced. The estimated cost of this work is $250,000. One and a half miles of water mains (6-in. to 12-in.) will be laid at an estimated cost of $21,500. It is probable that work on the new water intake will be begun; estimated cost, $50,000. The Niagara, Welland and Lake Erie Railway Company will construct about one and three-quarter miles of street railway on North Main, West Main and East Main Streets. The Niagara, Welland and Dunnville Railway Company will construct new lines on Patterson Avenue, Hellems Avenue and Plymouth Road, about one and a quarter miles. It is expected that work on the Welland Canal will commence in 1913. This will mean that under the present plans vast changes will be made in the present layout of the town. Extensive harbor accommodation will be provided and there will be two new heavy swing bridges installed. Town, engineer, D. T. Black.

Souris, Man.—The town anticipate installing an electric light plant at an estimated cost of $40,000. There will also be extensions of sewer and waterworks to parts of the town which are not already served. The present sewer and waterworks system has just been completed, and covers about eight miles of roads. Town engineer, Percy C. Smith.

Winnipeg Man.—The following is a statement of works under construction in this city, or to be constructed in the immediate future. A waterworks reservoir situated at the waterworks main pumping station, Logan Avenue, to be constructed of concrete, capacity 18,000,000 gallons. Excavation for this work nearly completed. In connection with the waterworks extension a series of fifteen wells are being constructed in a northerly course from the city at intervals of one-half mile, the wells being eighteen inches in diameter and to be bored to a depth of 300 feet. The water is conveyed by a steel pipe line eight and a half miles long, to the city. Estimated cost of the works complete, including erection of small pump houses, pumps, etc., is $1,000,000; operation started last week. In connection with the City of Winnipeg hydro-electric plant at Point du Bois, two new units are to be installed at Point du Bois, and a new transmission line erected from that point to the city. The estimated cost of the units with the transformers being $250,000, and of the transmission lines $750,000. This addition has been made necessary by the very large increase in the sale of power in the city. There will be the usual quantity of new work constructed within the city at an estimated cost of $1,000,000, consisting of sewers, water mains, plank and artificial stone sidewalks, asphalt, asphalt macadam, cedar block and macadam pavements. All city work and requirements are advertised and let by tenders. City engineer, H. N. Ruttan.

Department of Public Works, Manitoba.—The department have under construction two large drainage ditches to the west of Lake Manitoba, comprising some 600,000 acres of land, and another district has just been formed in the municipalities of Springfield and Broken Head, embracing 107,000 acres. A drainage system in the municipality of Dauphin is being formed, which will cover about 250,000 acres. Work will be begun on the ditches in the spring. The department have under construction at the Agricultural College at St. Vital a system of waterworks and sewerage. A very large amount of work will be undertaken by the various municipalities under the "Good Roads" and the "Improvement of Highways" Acts. This will be under the supervision of the highway commissioner, who is one of the officials of the department. The department has also under construction a number of important public buildings, namely, the Agricultural College, costing about $2,000,000; new law courts, costing about $1,000,000; insane asylum at Brandon, $500,000; and expect shortly to call for tenders for parliament buildings, which will probably cost $2,500,000. Deputy Minister, Chas. H. Dancer.

Regina, Sask.—This city will build at least eight miles of street paving and twenty miles of concrete sidewalks during 1913. City engineer, F. McArthur.

Saskatoon, Sask.—The following work is contemplated in this city for 1913. On account of the present financial

outlook, there is considerable uncertainty as to the amount of work which will be undertaken; therefore these figures provide only for absolute necessities. Extensions to the sanitary sewer and waterworks system, $400,000; house connections, $75,000; sidewalks, $75,000; pavements, $100,000; storm sewers, $30,000; extension to intercepting sewer, $40,000; additional sedimentation for water purification plant, $35,000; making a total in all of $755,000. However, if conditions from a financial standpoint have improved by spring some of this work will be doubled or trebled. City engineer, Geo. T. Clark.

Prince Albert, Sask.—In view of the present situation it is difficult to say how much work will be done during 1913. The following, however, gives an approximate idea: Street opening and grading, $50,000; sidewalks, $100,000; water main extension, $75,000; sanitary sewers, $100,000; storm sewers, $20,000; electric light, $60,000; disposal works, $60,000; power plant at LaColle Falls (in 1913), $500,000; new pumping plant, $75,000; steam power house, $50,000; making a total in all of $1,090,000. City engineer, F. A. Creighton.

Lethbridge, Alta.—During the past year the city has expended nearly $1,000,000 for improvements, nearly half of which was in connection with the installing of a street railway system. This coming year the ordinary extensions of present utilities will be made. The probable capital expenditure by the city during 1913 will be about $175,000, made up as follows: Sewer extension, three miles, $20,000; water extension, three miles, $80,000; cement walks, five miles, $20,000; street paving, one-quarter mile, $30,000; parks, $10,000; street railway extension, $15,000. There are other expenditures which do not show on the above statement. These include maintenance of all improvements and the expenditure of a large sum to operate the various utilities owned by the city. These utilities embrace a municipal coal mine, water and electric power plant, and street railway.

Medicine Hat, Alta.—The city expect to spend approximately the following amount on the works here listed: Domestic sewers, $150,000; surface sewers, $50,000; curbing, $30,000; sidewalks, $50,000; street grading, $35,000; paving, $250,000; water extensions, $100,000; gas extensions, $50,000; subways, $200,000; fire alarm system, $25,000; public improvements, $40,000; new parks and developments, $60,000; electric light extensions, $25,000; electric power plant extensions, $50,000; making a total of $1,135,000. In a general way it is anticipated that the expenditure of the city for the year 1913 will be $1,250,000. Medicine Hat owns its own water, electric light and gas plants, which are operated as public utilities. All public works are executed by the city construction department on a day labor basis. City engineer, A. K. Grimmer, M.Sc.

Calgary, Alta.—The city contemplates completing three concrete bridges at a cost of about $900,000. The installation of a sewage disposal plant; a water filtration plant; extension of the gravity system by two miles of 42-in. wood stave pipe; building of an asphalt paving plant at a cost of $50,000. Under local improvements there will be 500,000 sq. ft. of concrete walk; 300,000 sq. yds. paving; 50 miles of waterworks; 50 miles of sewerage, including 2½ miles of 42-inch trunk sewer, and an additional 2,000 ft. to the 6-ft. trunk sewer. City engineer, C. S. Dennis.

Macleod, Alta.—City are constructing a mechanical water filtration plant to cost $55,000. It is intended in 1913 to proceed with a system of sewage disposal at an estimated cost of $55,000. The construction of a new trunk sewer and extension to the sewerage system, approximate cost, $32,000. Plans are already prepared for a municipal town hall, to cost approximately $165,000. General improvements in water extensions, concrete walks, etc. City engineer, G. H. Altham.

Fernie, B.C.—By-laws voted on and approved by the city last year, amounting to $35,000, include street improvements; central school addition, and a concrete warehouse and workshop for the city. Provided the debentures are sold this coming year, the above work will be done. The Provincial Government Works Department is calling for tenders for an armory and drill shed, 80 x 130 ft., brick and concrete, with a steel roof truss. Estimated cost, $40,000. Sanitary sewerage system contemplated, $12,000. City engineer, Wm. Ramsay.

PROGRESS ON DESIGN OF QUEBEC BRIDGE SUPERSTRUCTURE.

Considerable progress has been made in the revised design for the double-track cantilever bridge now being built by the Dominion Government across the St. Lawrence River a few miles above Quebec. The board of engineers and contractors has very carefully revised and verified the contract design and modified it materially in some important features and has worked out the principal connections and details of members to an advanced stage of completion. As noted in the Engineering Record, in order to secure the greatest possible accuracy in the computation of dead load stresses and proportioning of cross sectional areas the stress sheets have been repeatedly revised to correspond with successive approximations of dead loads, so that the final stresses are computed from estimates of weight made from the details approved for the actual shop drawings. The detailing is being executed from the centre of the bridge towards the anchorages, and the suspended span has been completely designed, thus giving the true loads on the cantilever arms for which they can be accurately proportioned and the details of the anchor arms finally determined.

This method has the advantage of insuring such certainty and accuracy that Mr. Joseph Mayer, in charge of the computations for the board of engineers, expects to compute the total weight of the bridge within 1 per cent. of the actual shipping weight It is subject, however, to the disadvantage of completing the design first for that portion of the bridge which will last be erected and conversely finishing last the design for the portion which must first be erected. On this account no material has yet been ordered for any part of the superstructure except steel required in the anchorage piers and for the floor system which is independent of the design of the trusses. It is expected that the design and computations will be finished so that the truss material may soon be ordered in detail and fabrication of it commenced during the coming winter.

Some of the principal features of the contract design were illustrated and described in the Engineering Record of April 22 and May 27, 1911. The principal dimensions of the trusses remain the same, but the outline is slightly modified by the introduction of false members connecting the top chords of the centre span and the cantilever arms. The riveted top chord members in the cantilever and anchor arm trusses have been superseded by double lines of 16-in. eyebars in half-panel lengths. Their pins at sub-panel points pass through the webs of light lattice girders connecting the tops of the vertical posts to carry the dead weight of the eye-bars.

The bottom chord, about 10 ft. wide and 7 ft. deep, has a maximum panel length of 86 ft. Each panel will be composed of two pairs of built channels with a full length longitudinal diaphragm making an H-shape section. Each pair of channels has a field-riveted transverse splice midway between main panel points and the two pairs are field riveted together by three lines of very heavy lattice bars extending from end to end and thus forming a full length longitudinal

splice. Each full panel of the bottom chord is thus fabricated and erected in four separate pieces with a maximum weight of about 100 tons for each piece, or 400 tons for the full panel length of member.

The 30-in. pins at the feet of the main vertical posts and bottom chards will take bearing on a built-up pier member resting on sectional cast steel pedestals. The pier members will weigh about 500 tons each.

The stringers are through plate girders fully equivalent to ordinary viaduct spans and are seated with their bottom flanges supported on the top flanges of the floorbeams. One end of each slide to provide an expansion joint in every panel and thus avoid the possibility of transmitting longitudinal chord stresses through the floor system. Wherever the conditions are such that rigid connections between the floorbeams and the truss members might cause the development of excessive secondary stresses the floorbeams have one and sometimes two pin bearings. They are massive plate girders 10 ft. deep with a maximum weight of about 60 tons each.

A large force of draftsmen is now employed by the contractor in working out the details and making shop drawings, and for their convenience and assistance an accurate model of one of the anchor arms of the main trusses is being built in the contractor's city office, adjacent to the main drafting room. It is to a scale of 1/4 in. to the foot, with all compression members represented by solid rectangular pieces of pine to show relative dimensions without details. The eye-bars are made of thin sheet metal, cut to the required shape and dimensions, and the gusset plates and principal connections are also made of thin sheet metal bored for steel pins of proper dimensions. This model has been found very useful in showing relative positions, complicated connections and necessary clearances.

It is proposed to erect the anchor arms on massive steel falsework, which, together with the erection plan, are now being studied and designed. The erection problem is considered as a new and independent one to be treated as a whole with due recognition of local conditions and requirements rather than as the amplification of ordinary construction methods. Special attention is being given to the centre suspended span which will be erected on falsework and floated to position beneath the ends of the completed cantilever arms and connected through vertically slotted holes to ends of adjustable plate hangers suspended from the cantilever arms. The span will be lifted to position by specially powerful hydraulic jacks. In order that there may be no possibility of a drop on account of any failure of the jacks, the lifting movement of the latter is followed up by a system of power driven wedges, which prevent any slips of the hangers at all stages of the operation.

Extensive new shops with a complete equipment of powerful electrically driven machine tools have just been constructed for the fabrication of the steel work at Lachine, near Montreal, at an estimated cost of nearly $1,000,000, including the cost of the very valuable site. It is anticipated that this expense, together with the purchase of materials, cost of labor, equipment and erection plant, plus the required surety deposited, will aggregate $3,000,000 more than the contractors will have received in payment at the time erection is commenced.

The design and construction is under the direction of a board of engineers, composed of Mr. C. N. Monsarrat, chairman and chief engineer; Mr. C. C. Schneider and Mr. Ralph Modjeski. The contract for the steel superstructure was awarded to the St. Lawrence Bridge Company, of which Mr. Phelps Johnson is president, and Mr. G. H. Duggan, chief engineer. Mr. S. P. Mitchell, Philadelphia, has been retained as consulting engineer for the erection

THE GAS ENGINE AS AN ECONOMICAL POWER PRODUCER.*

By W. C. Mountain.

Gas engines have been very greatly improved in design and construction during the last few years and undoubtedly offer the most economical means of producing power. The heat consumption of large gas engines in practical working is about 10,000 B.t.u. at normal full load and about 9,500 B.t.u. at the maximum overload. The net heat value of blast-furnace gas varies with the duty of the furnace and the character of the fuel used, but in general varies between 90 and 110 B.t.u., or, say, 100 B.t.u. per cu. ft. as an average. Therefore, the consumption of blast-furnace gas per brake horse-power per hour would be approximately 100 cu. ft.

With coke-oven gas the heat consumption is the same. The heat value of coke-oven gas varies considerably, but is generally in the neighborhood of 450 to 500 B.t.u., occasionally less. Taking 450 B.t.u. as the usual figure, the consumption per brake horse-power per hour at normal full load is about 22½ cu. ft.

The exhaust gases from gas engines can also be used for generating steam, and when an engine is developing something like its full load, from 2 to 2¼ lb. of steam per brake horse-power at 60 lb. pressure is regularly generated, and this steam can be utilized for driving auxiliaries, heating and other purposes.

As regards the power available from blast-furnace and coke-oven plants, the following figures are interesting:

The calorific value and volume of gases evolved by a blast furnace depend upon the character of the furnace burden, and to some extent upon the method of driving, but, as an average figure (Northeast Coast practice) the gas evolved per ton of pig iron produced is about 160,000 cu. ft., measured at atmospheric temperature and pressure. Of this gas, about one-third is used by the ovens, about one-eighth by the blowing engines (if driven by gas engines), and about 10 per cent. is lost or used up in miscellaneous ways; thus about 45 per cent. of gas is available as surplus, or approximately 72,000 cu. ft.

Taking an average heat value of 100 B.t.u. per cu. ft., the horse-power developed by large gas engines would amount to about 30 brake horse-power for every ton smelted in 24 hours. If ordinary steam blowing engines were already installed, the available surplus would drop to about 25 brake horse-power per ton of pig iron in 24 hours, and might even
horse-power per ton of pig in 24 hours, and might even

With coke ovens the production of gas naturally varies with the quality of the coal, but an average figure is 10,000 cu. ft. of gas per ton of coal. The surplus gas, when regenerative ovens are employed, amounts to about 5,000 cu. ft. per ton of coal. Where non-regenerative ovens are employed, the surplus is very much less, sometimes amounting to 2,500 cu. ft. In these cases the high temperature of the escaping gases enables a good deal of steam to be evaporated by suitable boilers heated by the waste gases. Roughly speaking, about 1 to 1¼ lb. of steam will be generated for each pound of coal coked, and this steam may be used for driving steam turbines or other classes of engines. It will thus be seen how much power can be obtained by utilizing what was at one time a mere waste product.

---

* Abstract of the presidential address delivered at the annual meeting of the British Association of Mining Electrical Engineers, in Sheffield, England, Sept. 27, 1912.

CLAY PRODUCTS OF CANADA.

The actual production and sale of clay as such in Canada is as yet very small and practically limited to a small quantity of fire clay sold by a few operators. With this exception, all of the clay production in Canada is manufactured by the producer, states Mr. J. McLeish, B.A., chief of the division of mineral resources and statistics in his annual report.

The clay products made in Canada comprise brick of various kinds, including common and pressed, ornamental and fancy building brick, paving brick, firebrick, porous fireproofing brick and blocks, sewer pipe and drain tile, pottery and sanitary wares, the last two products chiefly from imported clays.

The production of clay products has been rapidly increasing, the value of the output having almost doubled in three years. The total value of the production in 1911 was $8,359,933, as compared with a value of $7,629,956 in 1910, showing an increase of $729,977, or over 9.5 per cent.

While the increase in gross output was not as large as that shown in 1910, the industry apparently made very satisfactory progress during the year.

Demand in most districts exceeded supply and higher prices generally were realized. For the year 1911 about 419 active firms reported, as against 438 active firms reporting for 1910. A larger number of men were, however, employed in 1911, an average of 9,131 being engaged, as compared with 8,656 in 1910; while the wages paid were $3,524,058 in 1911, as against $3,308,609 in 1910.

Considered by provinces, Ontario in 1911 had the largest output, being credited with 47 per cent. of the total value. Quebec was second with 16 per cent., Alberta third with 12½ per cent., Manitoba fourth with 10 per cent., followed by British Columbia with 8 per cent.

In 1907, Ontario contributed 54 per cent. of the production of clay products, while the western provinces contributed only 21 per cent., as against over 33 per cent. in 1911.

Of the total value of production in 1911, building and paving brick, including fireproofing, contributed $6,915,792, or nearly 84 per cent.; sewer pipe and tile production were valued at $1,152,528, or about 14 per cent. of the total.

The total value of the production of pottery was reported at $439,264, of which $102,493 is estimated as being attributable to Canadian clays and the balance to imported clays; the value of production of fireclay and firebrick was $89,130. Compared with the previous year, the production of building, paving and fireproofing brick shows an increase of nearly 12 per cent., while the production of sewer pipe and drain tile increased less than one per cent.

The average price of common building brick for the whole of Canada in 1911 was $8.37, as compared with $8.13 in 1910 and $7.81 in 1909. The average price of pressed or front brick for the same years was, respectively, $12.53, $11.89, and $11.01, thus showing the general increase in cost of building brick.

The total value of the imports in 1911 was at least $5,156,544 (certain items probably covering clay products not being included), showing a total approximate consumption of clay products valued at $13,416,537, of which only 62 per cent. was of domestic production.

In 1909 the approximate consumption was valued at $9,172,995, of which about 70 per cent. was of domestic production.

In the case of building brick, the imports while increasing rapidly are still small compared with the home production; it is different, however, with paving brick and firebrick. The imports of paving brick in 1911 were over twice, and the imports of firebrick nearly ten times the Canadian output.

While the production of sewer pipe and drain tile remained nearly stationary, the imports of these products more than doubled in 1911, and amounted in value to about one-third the domestic production.

CONSTRUCTION OF CONCRETE GRAIN ELEVATORS.*

By R. P. Durham.†

There is nothing in connection with the construction of foundations and first story of a concrete grain elevator, and very little in the construction of the cupola, calling for special comment as to method of procedure. Aside from the fact that foundation loads are exceedingly heavy and the item of the complicated construction sometimes necessary in the cupola, the ordinary methods of concrete warehouse construction are in general followed in building such portions of grain elevators. The building of the bin walls has, however, developed a method of construction not used, as far as I am aware, in connection with other buildings. This arises from the great height of bin wall of the same thickness, which early suggested that a short form which could be moved up continuously would be the most economical design.

All moving bin forms have certain characteristics in common, the variations between those used by different contractors, or by the same contractor at different times and on different work, being more in method than in principle. The form consists of horizontal framing pieces to which vertical sheeting is attached. The form may vary in height from 3 ft. to perhaps as much as 5 ft., measuring by the length of the vertical sheeting, but is always a comparatively short form. It must, of course, extend along both sides of each wall, the forms on the two sides of the wall being connected by vertical timber or steel yokes which are usually attached to the horizontal framing of the form. The sheeting is generally of wood dressed on the side in contact with the concrete. Galvanized sheet steel on a wood framework has also been used, and in some cases the wood sheeting itself has been covered with steel, either on the forms for the outside walls or on all the forms. The purpose of covering the wood sheeting or lagging with sheet steel has been to make smoother walls. It has been found that the use of steel is not necessary if the raising of the form is carried on rapidly and continuously and a gang of pointers follows closely after the moving forms. In such cases the wooden sheeting has produced workmanship which is all that can be desired and in some ways is superior to that produced by stationary forms.

The principal difference in methods of building bin walls with moving forms is dependent upon the procedure followed for raising the forms. It is necessary, in order to obtain walls which are smooth and results which are economical, that the forms be raised continuously and that the movement be at a steady rate. The concrete at any particular point must have a reasonable length of time to harden before the bottom edge of the sheeting gets above it. This means that the progress in any one day is limited to a maximum of approximately twice the depth of the form, which insures that there will never be any exposed concrete which is less than 12 hours old. Assuming a 4-ft. form, this means that the movement must not exceed 4 ft. in 12 hours, and it is generally less than that; so that a very slow, but at the same time a very steady, upward movement is desirable. It will probably be asked, Why not build forms with longer sheeting and jack faster? The answers are, first, that it is not desirable to put a much greater load on green concrete; and second, that 6 to 8 ft. of concrete a day on a large building has been found to be the maximum which can be got

* Abstract of paper delivered to National Association of Cement Users, Pittsburg, December 10-13, 1912.

† Vice-President, John S. Metcalf Company, Limited, Montreal.

into the forms, when the placing of reinforcing and other items tending to delay have been considered.

The Canadian Pacific Elevator at Port Arthur, built in 1903, was the first elevator as far as I am aware on which moving bin forms were used. The jacking was done by means of, I think, ordinary locomotive jack screws. Brackets were fastened to the lower horizontal members of the forms and the jacks were set on vertical posts, with the top of the jacks bearing against these brackets. As the forms were raised to the limit of each jack, another section of post was added below the jack and the entire form structure thus gradually raised from bottom to top by increasing the length of the post. The jack posts were probably of varying length so that all jacks would not have to be released simultaneously.

Another method of raising moving forms, and that used by our company at the Missouri Pacific Elevator, Kansas City, and on one or two other contracts, was somewhat similar except that the jack was placed at the bottom of the bin instead of at the top next to the form. Locomotive jack screws were placed below the posts and the entire form structure and scaffolding gradually raised, the new sections of post being put in at the bottom from time to time as the limit of travel of any jack was reached.

After this time, with the increased number of concrete elevators being constructed and the increased number of engineers working on schemes for raising the forms, the method of jacking becomes more diversified. The style of jacks may, however, be divided into two general classes, the screw jack and the pump jack. The former depends on the travel of a nut on some form of threaded rod, either in the jack or in the bin wall; the latter depends on a toggle arrangement operated by a lever with pump handle motion and working on a plain rod. Practically all builders now support the forms, not on a scaffolding between the bottom of the bin and the form, but on steel rods which are embedded in the bin wall. The jack travels upward on these rods, the jack itself generally being attached to the yoke, to the lower end of which the bin forms on either side of the wall are secured.

The question as to whether the pump jack or the screw jack is the better style is one on which experts disagree. Some who have used both kinds are very much in favor of the pump jack; others who have had experience with both kinds stick to the screw jack. We have experimented with the pump style, but have never seen fit to adopt it in actual construction work. We have used two or three different styles of screw jacks and have built about 10,000,000 bu. capacity of storage bins with the jack we are now using. In this case the vertical rod which is embedded in the wall, and on which the jack operates, is threaded the entire length with a double V-thread about 3½ pitch. The jack casting is attached to the yoke and consists of one supporting casting and a revolving casting with apertures for the jack levers. The revolving casting is set over a square nut on the threaded jack rod. As the revolving casting is turned the nut climbs the jack rod and the yoke and forms are raised. This jack enables us to make steady progress, is capable of exerting great power in case of the forms sticking, and is sufficiently fast. On two different sections of the Montreal Harbor Commissioners' elevator, each section being about 150 x 100 ft. in plan, we have run up 86 ft. of bin walls in less than 14 days, or better than 6 ft. per day. This is, of course, working night and day; for if a moving form is stopped after it is once started a joint in the work is sure to show, and generally a small offset or shelf is left at the joint.

One company uses another type of screw jack; in its case the vertical rod in the wall is a plain rod. The jack is, briefly, an extra heavy pipe about 2 ft. long and threaded on the outside. The jack rod runs through this pipe, which is provided with a clutch at the lower end. The travelling nut operates on the pipe and when the limit of travel has been reached the clutch is released, the threaded pipe run to the other end of the travel and the operation repeated. The company has secured good results with this jack. The Macdonald Engineering Company, of Chicago, on the other hand, after trying various styles of jacks, has abandoned screw jacks altogether and uses only a pump jack.

The rate of progress of which I have spoken is possible only with a comparatively quick setting cement such as is used in the United States and Canada.

It is not possible to build a very thin wall with a moving form, the determining factor being the relation between the weight of the concrete in the form and the friction of the concrete against the sides of the form. The area of form exposed to the concrete is the same no matter what the thickness of the wall, while the weight, of course, varies in direct proportion to the thickness. I think it is entirely practicable to build a 6-in. wall with moving forms, but that it is dangerous to go much below this unless very special precautions are taken to prevent lifting of the concrete. We have built concrete elevator legs 2 in. thick with moving forms and got good work, but in that case we lifted the forms with chain blocks and went with comparative slowness.

The speed of the work and the freedom from trouble will also depend somewhat on the aggregate used and, it would seem in some cases, on the cement. Three elevator builders have had trouble with one particular brand of cement in moving forms and decline to use it further. A fourth has used it with success and is not afraid of it. Whether the trouble arises from this particular cement having properties which cause it to stick to the forms more than other cements, or whether it sets before the forms have been moved and thus causes the top of the walls to break away from the portion below it, is a question no one, not even the cement people themselves, has been able to answer satisfactorily.

The question of aggregates seems to be a comparatively unimportant one. We have had good results with crushed stone concrete and with gravel concrete. The crushed stone concrete has, perhaps, less tendency to lift in the forms, but on the other hand, on account of the likelihood of sharp corners of the stones catching in the wood of the sheeting when tamped and thus being displaced as the form is raised, smoother walls are generally obtained with gravel concrete. We have successfully run bin walls with sand and cement alone, though in general we should consider this taking a chance because of the tendency of a concrete mortar to stick to forms.

CONCRETE BRIDGE DESIGN.

In a recent paper on concrete bridge design, Daniel B. Luten, Indianapolis, Ind., states that the ideal highway bridge must include among its qualifications the following: Permanence, eliminating repairs, artistic appearance to harmonize with its surroundings, strength, increasing with time and traffic, safety, meaning not merely security, but slow failure in case of defects; stable on insufficient foundations and under extreme flood conditions, effective waterway providing maximum discharge, efficient and economical in use of materials, employing home labor and materials, providing a roadway continuous over bridge and approaches, easily widened to provide for increasing traffic, easily modified in design to conform to improvement in surroundings, simplicity in design and erection.

SEWAGE TREATMENT STANDARDS.

By R. O. Wynne-Roberts, M. Inst. C.E., F. R. San. I.

The Royal Commission on Sewage Disposal has just issued its eight report, which deals with "standards to be applied to sewage and sewage effluents discharging into rivers and streams."

The commission has had under consideration tests of which three have been more fully investigated, viz.:

1. The quantity of ammoniacal nitrogen present.

2. The quantity of oxygen absorbed from permanganate in four hours.

3. The quantity of dissolved oxygen taken up in five days.

Of these tests the commission consider the last provides the most trustworthy chemical index of the actual state of a stream and should be adopted for purposes of a standard.

It appears that this test has been objected to an the grounds that it is difficult to carry out, and gives discordant results. But, in the opinion of the commission, the objection is not well grounded. A considerable number of chemists at different British sewage works have made numerous tests and with a little practice any well-trained chemist can apply it with ease, and obtain accurate results.

The commission concluded, after many experiments, that if 100,000 cubic centimeters of river water do not normally take up more than 0.4 gram of dissolved oxygen in five days the river will ordinarily be free from signs of pollution. If, on the other hand, a greater absorption of dissolved oxygen takes place, then the river will almost certainly show signs of pollution, except perhaps in very cold weather.

This "limiting figure," in the opinion of the Royal Commission, should be the foundation upon which standards should be based.

As temperature is an important factor, the results of five days' tests will vary during varying temperatures and different seasons. So, the commission carried out the experiments at a constant temperature of 65 deg. Fahr. A stream can be more highly polluted in cold weather without creating a nuisance and, therefore, the above standard temperature has been adopted.

The amount of dissolved oxygen taken up in five days by a mixture of river water and sewage effluent depends (a) on the amount taken up by the sewage, (b) on the amount taken up by the river water, and (c) on the proportion in which the two liquids are combined. A mixture complying with the standard of 0.4 parts dissolved oxygen per 100,000 of water may thus be expressed in equation form as follows:

$$\frac{x + yz}{z + 1} = 0.4$$

x = parts of dissolved oxygen taken up per 100,000 parts of effluent.

y = parts of dissolved oxygen taken up per 100,000 parts of river water above outfall.

z = dilution (proportion of river water to effluent).

Thus, for example, (given in report) if an effluent is discharged into 10 times its volume of water which itself takes up 0.1 parts of dissolved oxygen in five days the formula gives

$$\frac{x + (0.1 \times 10)}{10 + 1} = 0.4$$

$$x + 1 = 4.4$$

$$x = 3.4$$

In other words, the effluent in this case may be permitted to take up 3.4 parts of dissolved oxygen per 100,000 in five days and that figure would be the standard for this particular discharge.

The commission report goes on to state that a standard should be fixed which would be suitable for majority of places. But in Canada this must manifestly be varied, as what will apply in rapid streams will not suit sluggish and small streams. This is a point which the report deals with when it states that provision should be made for fixing one or two higher or lower standards to meet cases in which a different standard could be justified.

After making allowance for the practical difficulties in the way of removing suspended solids in a uniform manner, the commission considers that the dissolved oxygen test should be applied to the effluent as discharged, that is, with its suspended solids, and recommend that the normal figure for dissolved oxygen absorption test should be fixed at 2 parts per 100,000.

An effluent which takes up 2 parts of dissolved oxygen in five days will need some dilution if nuisance is to be avoided. The minimum degree of dilutes required for safety is to be found by means of the formula

$$\frac{2 + (0.2 \times z)}{z + 1} = 0.4$$

$$z = 8$$

The commission recommend that in the case in which a complete system is called for, the effluent should not contain more than three parts of suspended matter per 100,000, and that, including its suspended matters, it should not take up more than two parts of dissolved oxygen per 100,000 in five days at 65 deg. Fahr. (18.3 deg. C.). This standard is given for normal conditions and in special cases should be modified.

Where the dilution is very low it is suggested that the standard should be made more stringent, and if the dilution is very great the standard may be relaxed.

The commission state that their experience leads them to think that as a general rule if the dilution, while not falling below 150 volumes, does not exceed 300, the dissolved oxygen absorption test may be omitted, and the standard for suspended solids fixed at six parts per 100,000.

There are several other points of interest in this report which may be referred to later on.

LATHE FOR TURNING PROJECTILES.

A motor-driven lathe for turning projectiles has recently been developed. This service requires rigidity of equipment and wide speed range; a very high spindle speed is necessary when finishing the point of the projectiles. The lathe, which is of Pond make, is especially designed for individual motor drive, and is not a belt-driven lathe modified for motor drive; the motor is placed on the lathe head, thus saving floor space, and doing away with any chance of injury to employees from coming in contact with the motor or gears; at the same time the motor is protected from harm.

The control handle is to the extreme right of the tool apron, and very convenient for the operator.

The lathe is driven by a Westinghouse 20-h.p. machine tool motor, 400-1,500-r.p.m. Commutating poles insure excellent commutation at all loads within its capacity.

With the liberal speed adjustment of the motor, in combination with the gear-changing device operated by means of the levers at the left end of the tool, the wide adjustments needed in turning up projectiles are made readily available.

LIME-SAND BRICKS.

The manufacture of lime-sand bricks on a commercial scale was commenced in Germany about the year 1894, since which time many improvements have been made in the design and construction of machinery especially adapted for the purpose. That the industry is far beyond the experimental stage is proved by the fact that in Germany numerous plants are in operation, producing, it is estimated, over 1,000,000,000 per annum, Berlin alone consuming 400,000,000 annually. In the United States about 150 plants are in operation and many are being erected, the output for 1910 in the States being estimated at 350,000,000. In other countries the progress has been slow, but plants are now being erected in all parts of the world.

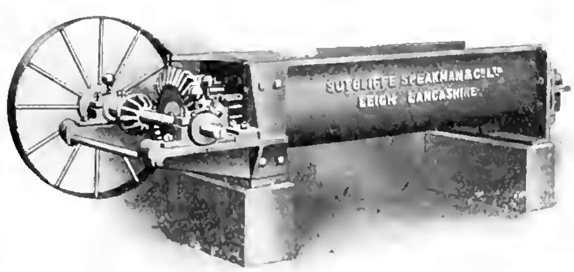


Fig. 1.—Differential Mixer.

Lime and bricks, as their name implies, are made from a mixture of slaked lime and sand. These materials, being suitably prepared and thoroughly mixed, are pressed into brick form by powerful presses, and then hardened by the action of high-pressure steam in suitably closed hardening chambers or vessels for a period ranging from eight to ten hours, the whole period of manufacture from taking the raw materials to completion ready for building not exceeding 24 to 26 hours.

They possess many advantages. Being perfect in shape, and uniform in size, less mortar is required in laying them, and when used for inside walling one coat of plaster is sufficient, the face of the wall being quite true. Their specification and use by the governments of Australia, Germany, Sweden, America and other countries are sufficient to prove that they are found to have all the weather-resisting and other properties of a durable brick. In general, they have the appearance of a natural sandstone, and may be compared to a good even-grained one; in fact, there are many varieties of sandstone from which they cannot be distinguished. They are cheap to manufacture, being made at a less cost than clay bricks, and when reasonable care is taken in making them, every brick is a facing brick. Their natural color depends upon the sand and lime used; generally they are white or gray, but variety in color may be obtained by the use of coloring ingredients.

PRINCIPLES OF MANUFACTURE.

Percentage of Lime Required.—As mentioned before, they are made from a mixture of sand and lime, the proportions varying with the kind of sand and the purity of the lime. A good, clean, silicious sand, consisting of well-graded fine and coarse particles mixed with 5 to 6 per cent. of a good fat lime gives excellent bricks, but in some cases up to as high as 8 or even 10 per cent. lime will be required. If the lime is hydraulic or an impure lime, or is not thoroughly calcined, the higher percentage is required. The average composition may be taken to run as follows:

Sand	85 per cent.
Lime	8 per cent.
Water (in combination)	7 per cent.

Preparation of the Materials.—Before the materials are ready for pressing it is necessary to ensure that the lime is thoroughly slaked, or hydrated and the mixing of the lime and sand intimately effected. If this is not effected the bricks will either crack or swell during the steaming, or be of a very weak and friable nature. When the manufacture of these bricks was first commenced, it was thought to be a simple matter to slake the lime, and that it could be done in the same way that builders prepare their lime. This method was soon proved unsuitable. If insufficient water was added, the lime was not slaked, and if too much water was added, the lime was made too wet, and it was impossible to make a homogeneous mixture. To overcome this difficulty, numerous methods have been adopted and the difficulties overcome as they have arisen by such systems as the nature of the material and the existing conditions on the site may demand. Exhaustive tests have proved that by proper methods lime-sand bricks of good quality may be made under almost any conditions, and that crushing strength and absorption varies with the qualities of the sand and lime used. By finely grinding through a tube mill of the preliminary mixture the results are excellent as the following figures from results of tests made will show:

	Crushing strength in tons per sq. foot.	Absorption.
Ordinary bricks made without fine grinding through tube mill, tested when 3 days old	150 to 400	8 to 12 per cent.
The same, but material treated in tube mill	300 to 600	3 to 7 per cent.

It is well known that lime-sand bricks improve with age, due to the further combination of lime and silica and to the absorption of carbonic acid from the atmosphere converting any uncombined lime into a carbonate.

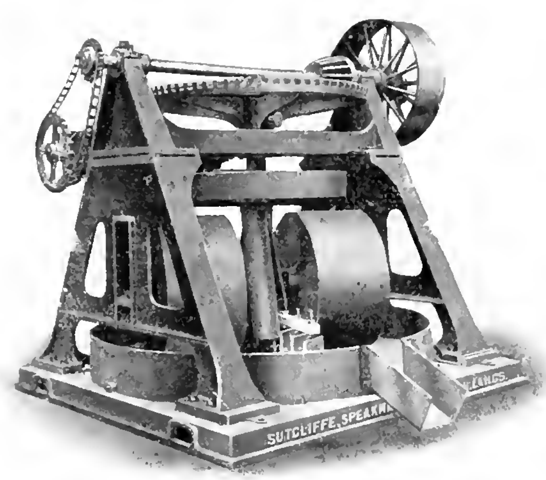


Fig. 2.—Edge Runner Mixing Mill.

Pressing the Bricks.—For pressing the material into bricks, the press must be a strong and powerful one, the bricks requiring a pressure of at least two tons per square inch, or a load of 80 tons on each brick. One hundred tons is preferable and is recommended. The pressure must be applied slowly in order to press out the air, and when the bricks are required for facing purposes they should be pressed equally on top and bottom.

Hardening the Bricks.—After coming from the press, the bricks are stacked closely together upon platform wagons, each wagon holding 650 to 800 bricks. They are then wheeled into hardening chambers or autoclaves. These are steel cylindrical vessels similar to Lancashire boilers without

flues, one or both ends being fitted with a removable door. In these chambers the bricks are subjected to the action of steam at a pressure of 120 lbs. per square inch for a period of 8 to 10 hours. This treatment hardens the bricks and when drawn from the chambers they are ready for use.

Machinery and Plant Used.—For a successful manufacture of these bricks it is necessary that machinery of high-class make, specially designed for the purpose, be employed.

Through the courtesy of Messrs. Sutcliffe Speakman and Co., some particulars of the machinery they make for this industry are herewith given.

For the fine grinding of the lime an improved ball mill is used. These mills are made in sizes depending upon the work to be done.

When the fine grinding of the preliminary mixture is adopted, the use of the tube mill is recommended. This mill consists of a long steel tube, revolving on tyres and rollers. The tube is lined with silica paving, and is charged rather more than half full with hard flint pebbles. The material to be ground is fed in at one end, and passes out automatically at the other end, the grinding being effected by the rolling and tumbling of the pebbles on the material.

The differential mixer is illustrated in Figure 1. Various sizes are made to suit the output required. It is used both for the first mixing of the materials for the silo and for the final mixing prior to the mixture being pressed into bricks. The mixer consists of two shafts carrying knives or blades set at an angle to propel the material through the containing trough. One shaft revolves twice as fast as the other and the two shafts revolve in opposite directions. It forms a very simple and efficient mixing apparatus.

The mixing mill is shown in Figure 2. It consists, as shown, of two rollers revolving in a stationary pan, and so works that the material is not only turned over and mixed by the scrapers, but at the same time the crushing action of

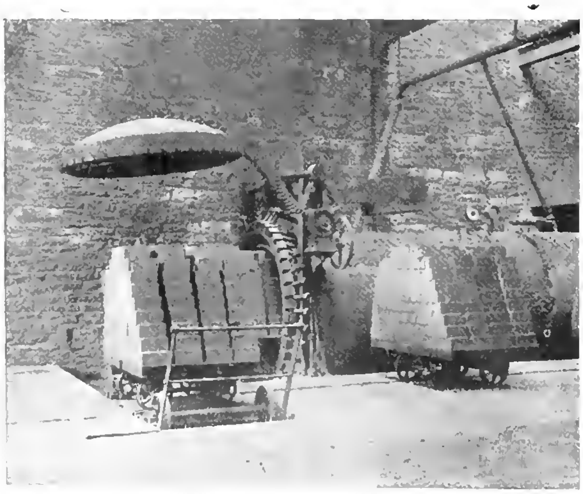


Fig. 3.—Hardening Chamber End, Showing Door Opening Arrangement.

the rollers gives a kneading effect. It gives a mixture in which each particle of sand is painted or covered with a thin coating of lime. It is made in various sizes and with rollers ranging up to five tons in weight each.

In any lime-sand brick plant one of the most important items is the press, as upon this depends more particularly the output, the general quality, and the finish of the bricks.

After an extensive experience in press manufacture, the result of the company's work is the "Emperor" press. This is a rotary table press capable of pressing the bricks equally from top and bottom.

The hardening chambers are specially designed for the required pressure, usually 125 lbs. per square inch, and are constructed in accordance with the requirements of the insurance companies. The most usual diameter is 6 ft., but on occasion they are made up to 6 ft. 6 in. and 7 ft. in diameter. Figure 3 shows the ends of a chamber and the arrangement recommended for opening the door.

When fuel is expensive and freights high, and first cost of plant is required to be reduced as far as practicable, small hardening chambers are supplied 3 ft. in diameter,

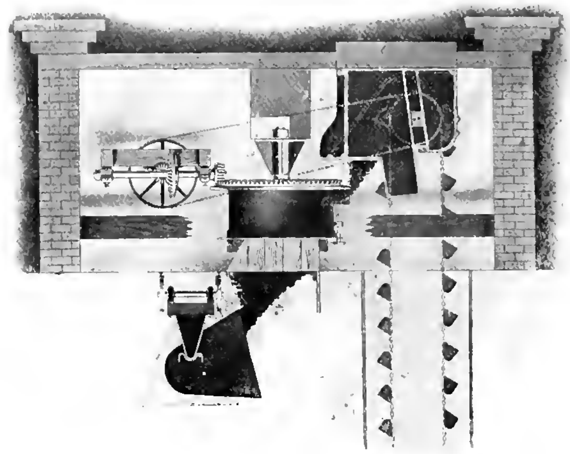


Fig. 4.—Automatic Feeder.

working at 200 lbs. pressure. This admits of steaming being effected in four hours, and if the chambers are so arranged that they can be operated day and night, the saving of steam is considerable, as one chamber can then be arranged always to exhaust into one ready for steaming.

For automatically measuring the feed to elevators and mixers circular automatic feeders, as illustrated in Figure 4, are used. This illustration shows the feeder automatically feeding an elevator. A wagon load of material can be tipped into it at one time, and it can be adjusted to pass the material at the required rate of feed.

This prevents the possibility of choking the elevators, and does away with the necessity of labor feeding the machines or elevators, whilst at the same time it acts the part of a measurer

MOVING A LONG BRICK WALL.

In order to widen the train shed of one of the railroad stations in Antwerp, Belgium, it was found necessary to move a brick wall, about 236 feet in length, a distance of 80 feet. The plan first decided upon consisted of demolishing the wall and rebuilding it of the same material at the new location, but when the contractor undertook to do this he found that the masonry construction was so solid that tearing it down would so damage the old material that it could not be used again. Therefore, he had the wall cut off in one solid piece, and moved on rails to its new location. The complete operation was accomplished by 18 men in 14 days, the actual moving taking but 27 minutes. The plans were so well carried out that not even one crack appeared in the wall.

At Souris, Manitoba, a money by-law to authorize the expenditure of $40,000 for electric lighting was defeated because the majority was one vote less than the required sixty per cent. necessary for it to become law.

MINING IN ALASKA IN 1912.

The annual report on the mineral resources and production in Alaska for 1912 is now in preparation, under the direction of Alfred H. Brooks, of the United States Geological Survey. Some of the important features of this report relating to mining development during the year are abstracted in the following statement. Complete statistics of the mineral production of Alaska cannot be collected within less than four or five months after the close of the year, but meanwhile it appears advisable to give prompt publication to preliminary estimates, which are believed to be not over 5 per cent. in error.

Value of Mineral Output.—It is estimated that the total value of the mineral output of Alaska in 1912 is $21,850,000, compared with $20,650,000 for 1911. The value of the gold output of 1912 is estimated at $16,650,000; that of 1911 was $16,853,256. It is estimated that the Alaska mines produced 28,940,000 pounds of copper in 1912, valued at about $4,630,000. In 1911 the output was 27,267,871 pounds, valued at $3,364,584. The silver production in 1912 is estimated to have a value of $300,000, as compared with $243,923 for 1911. The value of all other mineral products in 1912, including tin, marble, gypsum, coal, petroleum, etc., was about $260,000, compared with $176,942 in 1911. The total value of Alaska's mineral production since 1880, when mining first began, is, in round numbers, $229,000,000, of which $202,000,000 is represented by the value of the gold output. The total output of copper in Alaska since 1901 is about 90,000,000 pounds, valued at about $13,145,000.

Important Features.—The increase in the value of Alaska's mineral output is to be credited to the larger copper output as compared with the previous year. While no new copper properties were put on a productive basis, a large amount of development work was accomplished in several of the copper-bearing districts. The gold-mining industry was marked by important advances in developing lode deposits. Work was continued on a number of large lode-mining enterprises in the Juneau district, and considerable advances were made at Fairbanks and in other districts. In addition to this, promising discoveries of auriferous quartz were made at Port Wells and in the Innoko-Iditarod region, as well as in other parts of the territory.

The output from the placer mines was less than in the previous year. On the other hand, discoveries of rich auriferous gravels were made on Hammond Creek and in the Koyukuk Valley, and workable placers were found in the Ruby district. Extensions of gold-bearing gravels were also found in several of the older districts. The installation of large plants has not yet gone ahead rapidly enough to insure the keeping-up of gold-placer production. It is significant, however, that the output in Seward Peninsula was practically the same as that of 1911. The maintenance of this output in Seward Peninsula is to be credited to the installation of dredges, which was continued in 1912, as in the previous year. The data at hand indicates that in 1912 about 40 dredges were operated in Alaska, besides a number of others under construction. Of these, three are in the Fortymile district, one in the Fairbanks district, one in the Birch Creek district, one in the Iditarod district, one on the Kenai Peninsula, and the rest on Seward Peninsula.

There has been no change since the previous year in the opening of coal fields. One coal mine was operated for a part of the year at Chignik, in the Alaska Peninsula, and the mining of coal for local use was carried on in a small way at several other localities. Investigations were made in the Bering River coal field under the joint auspices of the Navy Department and the Bureau of Mines, to determine the availability of coal for naval use. One well was drilled at Katalla, and there was a small production of petroleum from this field, the oil being refined near the well, and the gasoline disposed of in the local market.

Transportation.—Except for the continuation of the work of the Alaska Road Commission in the building of wagon roads and trails, there was no marked improvement in transportation facilities during the year. The total railway mileage for Alaska in 1912 is 465, the same as in the previous year. Most of the railways were operated, except those in Seward Peninsula. The Copper River and North-western was blocked by landslides for about six weeks in the early fall.

In accordance with an Act of Congress, the Alaska Railway Commission was appointed about the 1st September, and spent about three months in the territory investigating railway routes and conditions of transportation. The report of this commission is in preparation.

Gold-Lode Mining.—It is estimated that there were about 22 gold-lode mines in Alaska that made some production in 1912, compared with 18 in 1911. In addition to this, development work was done on many lode prospects widely distributed over the territory. The value of the output from the auriferous lodes in 1912 is believed to be about $4,600,000, an increase of about $400,000 over that of the previous year. This increase must in large measure be credited to the Treadwell group of mines, but there was also a considerable production from various small properties in different districts.

South-Eastern Alaska.—The most notable mining advances in the territory during the year were those in the Juneau district. The Treadwell Mine increased its gold output. Work was continued on the 6,000-foot tunnel of the Alaska-Juneau Mine, and was begun on an adit tunnel of the Alaska-Gastineau, which will be about two miles in length. This tunnel is to undercut the Perseverance Mine, which, with adjacent properties on Sheep Creek, has passed under one management. The ore is to be carried to a mill of 6,000 tons daily capacity, which is to be erected at Tidewater. These enterprises, together with the continuation of work on the Kensington Mine and the reopening of the Jualin Mine, in the Berners Bay district, constitute an assurance that the production of gold in Alaska will not fall off, even aside from the promise of a larger output from other parts of the territory. It is reported that discoveries of rich gold-bearing quartz veins have been made on Funter Bay, Admiralty Island. Two mines were operated in the Sitka district, as in the previous year, and the discovery of a new gold-bearing quartz vein in the district is reported.

There was considerable advance of auriferous lode mining in the Ketchikan district during the year. The Goldstream Mine was again operated, supplying a 5-stamp mill. A 10-stamp mill was installed at the Valparaiso Mine. Two adit tunnels were started to intersect an auriferous quartz vein on the Buggy property, near Smugglers Cove. It is reported that the Lon de Van Company intersected an auriferous galena-bearing vein, at a depth of 1,100 feet, on its property located on Georges Inlet.

Prince William Sound.—The Cliff Mine, of the Valdez district, continues to be the only gold-lode property in the Prince William Sound region, which has made a considerable output. In the aggregate, however, considerable ore has been recovered from other properties incidentally to development work. At the Cliff the opening of the fifth level is the most important development of the year. Sinking was done on the Alice property, at Shoup Bay, and preparations made for installing a mill. Development work was also continued on the Mayfield property, about nine miles from Shoup Bay, near the Columbia Glacier, where an ore

body has been opened on two levels. At the Ramsay and Ruthford property, east of the Valdez Glacier, a mining plant was installed and considerable development work accomplished, the ore being opened to a depth of 90 feet below the outcrop. There was much prospecting in the northwestern part of Prince William Sound and vicinity. Port Wells, and the adjacent fiords. Accounts from this district indicate that the ores are similar to those of the Valdez region. Considerable development work was accomplished on several properties in this field.

Kenai Peninsula and Willow Creek Districts.—Work was continued on the auriferous lodes of Kenai Peninsula and the Willow Creek district. Three small mills, two on Falls Creek and one on Porcupine Creek, were operated for a part of the year. In addition to these, two arrastres and one prospecting mill were operated in the Moose Pass district. Considerable work was also done on properties on Porcupine Creek, near Seward, and on Palmer Creek, near Sunrise. A gold-lode prospect was opened near Bird Point, on Turnagain Arm, and a small shipment of ore for testing was made. Three mills were operated in the Willow Creek district, and development work was advanced. It is reported that two of these properties are to be consolidated and opened on a large scale. The information at hand indicates that several promising discoveries of auriferous lodes were made in this district during 1912.

Fairbanks District.—Although the output from the Fairbanks placers has decreased, there was far greater activity in lode mining and prospecting than in the previous year. Most of the operations were conducted on a small scale, and the total output of gold was not large, but a very considerable amount of development work was accomplished during the year. In 1912 six stamp mills, aggregating 24 stamps, were operated for a part of the year, and six other mills were being installed in the late summer, and some of these were put into commission before the close of the year. Statistics at hand indicate that the average recovery of free gold from these operations is about $50 a ton. In only two places are the concentrates being saved, though they undoubtedly contain additional gold.

Lode prospecting has continued with increasing activity during the year, and probably more than 200 men were engaged in this work. As a result a number of quartz veins were disclosed, some of which promise well. The notable features of the lodes are their great number, small size, and high tenor. Most of the veins from which free gold can be obtained by panning are composed almost entirely of quartz, with sulphides either absent or present only in subordinate amounts. Stibnite is the most common of the sulphides. Most of the veins have been discovered in two areas—one stretching east and west from Pedro Dome, and the other in the vicinity of Ester Dome. It seems probable, however, that this distribution may be accounted for by the localization of the prospecting rather than by the actual limitations of the distribution of auriferous veins. But few of the richer veins so far discovered are more than one or two feet in width, and the gold is, as a rule, confined to the vein itself. In some places, however, gold has been found in adjacent mineralized country rock. In general the results obtained by the work of the year have been satisfactory. No large veins have been discovered, but a large number of small ones have been found. The development has been largely carried on by local ,capital, and most of it has been well advised.

Lode Mining in Other Districts.—The influx of prospectors into the Innoko-Iditarod region during the last two years has stimulated the search for lode deposits, but little has yet been accomplished in actual development. In 1912 an auriferous quartz deposit was opened on Gaines Creek and a small mill was installed. This operation has been successful, and is an indication of the possibilities of lode mining. More important is the fact that many other metalliferous veins have been found, and that the geologic conditions are favorable to their occurrence in considerable areas of the Innoko basin and adjacent portions of the Kuskokwim basin.

The Apollo Mine, on Unga Island, continued in 1912 to be the only productive lode mine in South-Western Alaska. Some work was continued on lode prospects in the Iliamna region, notably on the Duryea silver-lead deposit.

There was but little advance in quartz mining during 1912 in Seward Peninsula. Some prospectng was done, as well as assessment work, on a large number of claims. The New Era Mining Company opened a quartz lead near Snow Gulch, where a 4-stamp mill has been installed. Considerable ore was also treated at the Nome custom mill. Plans have also been made to install a stamp on a property located near Bluff, 60 miles east of Nome.

Copper Mining.—The increased copper production of 1912, compared with 1911, is to be credited to the Chitina and Prince William Sound districts. The rise in the price of copper led to much prospecting and deadwork in these as well as in other districts.

The Jumbo and Rush and Brown Mines were the only considerable shippers of copper ore in the Ketchikan district. It appears that the Mount Andrew Mine was idle for most of the year, but plans have been formulated for systematic development. Developments were continued on the It, the Red Wing, the Vittory and the Lhote and Sanford properties, and steps were taken looking to the reopening of the Copper Mountain Mine. Some work was also done on a copper-bearing vein at Sum Dum, in the Juneau district.

The Kennicott-Bonanza Mine is the only one in the Kotsina-Chitina district from which shipments were made in 1912, but a large amount of development work was done on other properties. The concentrator installed in 1911 at the Bonanza Mine was operated during 1912. At the east end of the field work was continued on the Mother Lode, Nikolai, and Westover properties, and also on a property located on an island in the Kennicott Glacier. Prospecting and developing were especially active in the vicinity of Kuskulana River. Here the largest operations were those of the Great Northern Development Company, which completed about 5,000 feet of development work. The Alaska Consolidated Copper Company carried on development work on Nugget Creek and on the Rarus group of claims. The Alaska United Copper Exploration Company continued work on the Blackburn group of claims, located on Porcupine Creek. In addition to the above, a large number of claims were being opened in the Kuskulana region during the summer of 1912. This field is now readily accessible from the railway, and a branch has been surveyed which would permit the shipment of ore.

On Prince William Sound shipments were made by the Ellamar Mining Company, the Threeman Mining Company, the Landlocked Bay Copper Mining Company, and the Beatson Copper Company, located on Latouche Island. In addition to productive properties, there were a large number of claims on which development work was carried on, some of which give promise of soon reaching a shipping stage. A notable advance was that made on the Solomon Gulch property, near Valdez, where a force of men engaged during the year in opening a chalcopyrite ore body.

But little advance was made in copper prospecting in those inland districts, which are far from transportation. About 25 men are said to be carrying on prospecting and as-

sessment work in the White River region, and there are also some in the Nabesna district. Prospectors report the finding of copper ore on Sheep Mountain, in the Matanuska Valley. Some copper ore has also been found on a tributary of the McLaren River, in the headwater region of the Susitna. A little development work was also continued on the copper prospects of the Iliamna region, in South-Western Alaska.

Tin.—The dredge which was installed on Buck Creek last year was operated throughout the open season of 1912. It is currently reported that the output of 1912 is much larger than that of 1911. The Lost River lode-tin property has been bonded, and is now being systematically developed The results of these operations in 1912 are reported to justify further investments and the installation of a mill. This property promises to become the first productive lode-tin mine in Alaska.

Placer Mining.—The returns from the Alaska placer mines are far from being complete, but the information at hand indicates that the value of the output in 1912 was half a million dollars less than that of the previous year. This decrease in production is due to the fact that the output from the Fairbanks and Innoko-Iditeraod regions was considerably less in 1912 than in 1911. On the other hand, a discovery of rich placer ground was made in the Koyukuk district, and promising finds were made in the Ruby district and the Innoko-Iditerod region. Moreover, the two years' work brought additional proof of the adaptability of the dredge for placer mining in different parts of the territory.

No noteworthy changes took place in the placer mining districts along the Pacific seaboard, which are relatively unimportant. A little mining was done at Juneau, and some larger operations were carried on in the Porcupine district. Beach mining continues to employ a score of men at Yakataga, and probably as many more in South-Western Alaska, notably on Kodiak Island.

The season in the Nizina district was successful, except for the floods which occurred in the latter part of the summer, and caused much damage to the two large plants there installed. The plant on Chititu Creek was, however, put into working order again before the close of the season. Mining continued as in previous years in the Chistochina district, but was considerably less in the Valdez Creek district, chiefly because a large number of claims were under bond to a company which proposed to install a large hydraulic plant.

Hydraulic operations were continued on Kenai Peninsula and at Crow Creek, as in previous years. A dredge installed in 1911 was operated on Kenai River for part of the season of 1912. There was also considerable prospecting in this part of the field for dredging ground.

It is reported that the Yentna district had a very prosperous season. Notable increase in production was made on Dollar Creek, where some high gravels were developed. A few prospectors continue work in the Mulchatna region, west of Lake Clark, but no important discoveries have been made in this field.

Yukon Basin.—The Fairbanks district continues to lead in the production of placer gold. The new discoveries in this field were principally those on creeks which have already yielded some gold. The most important was on Eva Creek. The work of the year has also considerably increased the area known to be underlain by workable gravels in the Chatanika Flats, near the mouth of Dome and Cleary Creeks. Additional gold-bearing gravels are said to have been found on Fairbanks Creek. The Fairbanks Creek dredge was operated throughout much of the open season. The gold produced at Fairbanks came chiefly from Goldstream Creek, the lower parts of Dome and Cleary Creeks, and Ester, Eva, and Fairbanks Creeks. It is estimated that between 130 and 140 different plants were operated, and that from 900 to 1,500 men were employed. Summer operations were much in excess of those of the winter.

In the Circle district the placer gold was taken chiefly from the mines of Mastoden, Deadwood, Eagle, Mammoth, Switch, and Independence Creeks. It is estimated that about 27 mines were worked during the winter and 32 in the summer of 1912, employing from 60 to 100 men in the winter and from 145 to 175 in the summer. A dredge installed on Mastoden Creek was operated during the summer of 1912. Hydraulic plants were operated on Mammoth, Mastoden, and Eagle Creeks.

The Fortymile district had a successful season. Three dredges were operated there during the summer. It is estimated that about 25 mines were operated in the winter of 1912, and about 50 during the summer. Many of these were, however, only small plants.

It is reported that the Koyukuk district had a very successful season in 1912, but details are lacking at this writing. A large amount of gold is said to have been taken from the newly discovered deep placers of Hammond Creek, and this production may have been sufficient to more than double the output of the district, compared with previous years.

Though the current reports from the Ruby Creek district have been rather discouraging, yet it seems certain that this district will become a gold producer of some importance. In 1912 operations were practically confined to six creeks, all lying within a small area about 25 miles south of the town of Ruby, on the Yukon. The creeks on which productive mining has been carried on are Long Creek, Upper Long Creek, Bear Pup, Midnight Creek, Glenn Gulch, and Trail Creek. About 150 men were employed in this district on 30 claims, and the value of the gold production was probably in excess of $150,000.

About 24 claims, located on five creeks and employing 140 men, were worked in the Innoko district during 1912. No new discoveries were made. In the Iditarod district Otter and Flat Creeks continue to be the most important producers of placer gold. Work was also done on Chicken, Willow, and Happy Creeks, and a little mining was carried on about Moore Creek, located about 30 miles farther east. A dredge was installed on the upper part of Flat Creek during the winter of 1912, and was operated for the latter part of the open season. It is estimated that 34 mines were operated in the Iditarod district in 1912. These were distributed on six creeks, and employed about 650 men. Of these plants one is a dredge, eighteen are equipped with steam machinery, and the rest are operated by manual methods.

During the summer of 1912 gold was discovered on Fox Gulch, a tributary of Cripple Creek, 30 miles north-east of Ophir, which created considerable local excitement. About a hundred men are said to be prospecting in this field. It is reported also that some workable placers were found on Mud River, a north-westerly tributary of the Innoko.

Prospecting continued in the Aniuk River basin, where gold was found in 1911. A small amount of productive mining was done in this region in 1912. Nothing of importance has developed in the Goodnews Bay region, where several claims, however, were operated in 1912.

Gold Dredging on Seward Peninsula.—There was no abatement in dredge installation on Seward Peninsula in 1912. It is reported that during the year 39 dredges were completed or in process of erection. The dredge season began in May, but most of the machines were not operated until the first steamers brought in the dredge crews, about June 15. Information at hand indicates that by August some 30 dredges were in operation, and that a number of others were started before the close of the season. Dredging con-

tinued until about the middle of October. It is a significant fact that these dredges are widely distributed over the peninsula, some being operated or under construction in every district which has yielded placer gold. This brings the final proof that profitable dredging ground is by no means confined to the vicinity of Nome, to the Solomon River valley, or to the vicinity of Council, as at first believed. The limitations on profitable dredging seem to be controlled rather by the cost of transportation, and especially of fuel, than by the physical condition of the gold-bearing gravels. Another significant item is that, in spite of the drought of the early part of the summer, and the fact that the value of the winter clean-up was only $400,000, the production of gold for the season was nearly the same as that of the previous year. This indicates that a large part of the gold production came from dredging operations which were not seriously hampered by small water supply. It is fair to assume, therefore, that the production of placer gold from the peninsula has passed its minimum for many years to come.

EFFECT OF ELECTRIC CURRENT ON CONCRETE.*

During the last few years attention has been called to the possibility of damage to reinforced concrete structures by stray currents from electric railways and other power sources. The laboratory experiments of Toch, Knudson and Langsdorf, in 1906 and 1907, showed quite clearly that under certain circumstances the passage of electric current from the reinforcing material out into the concrete gave rise not only to serious corrosion of the reinforcing material but also to cracking and disintegration of the surrounding concrete. Since then numerous laboratory experiments have been carried out by various investigators, all tending to confirm the earlier observations in regard to the destruction of the concrete, but giving rise to numerous conflicting theories as to the cause of the phenomena observed.

Following the early demonstrations of the possibility of damage to concrete by electric current, reports of serious damage to certain concrete buildings, bridges, etc., have been circulated from time to time, and considerable apprehension has been aroused in some quarters that great damage may be in progress due to this cause. The subject was brought directly before the U.S. Bureau of Standards by numerous letters of inquiry from engineers, contractors and corporations, requesting information in regard to the probable extent of the damage and the most feasible methods of preventing it. Although a good deal of work has been done showing that under certain conditions, readily produced in the laboratory, blocks of reinforced concrete could be completely destroyed by electric current, there remained a wide diversity of opinion as to the cause of the phenomena observed. Recognizing the great practical importance of the subject, and acting in response to requests from numerous sources, the Bureau of Standards has since the summer of 1910 been conducting a thorough investigation of the cause and extent of damage to concrete by electric current and the best methods of mitigating the trouble under practical conditions.

The investigation has been conducted along the following lines:

(1) Laboratory studies of the cause and nature of the phenomena caused by the passage of electric currents through concrete.

(2) Observation in the field with the view of establishing definitely the probable extent of the danger in practice and the circumstances under which trouble is most likely to occur.

(3) A study of the various possible means of mitigating trouble from this sourse, leading to specific recommendations based thereon.

The reports of previous investigators that the passage of current from an iron anode into normal concrete caused destruction by cracking were only partly confirmed. This effect did not occur in most of the specimens tested when the potential gradient was less than about 15 volts over a distance of 3 in. or about 60 volts per foot of anode.

Among the numerous theories that have been advanced for the cracking, the one which attributes it to oxidation of the iron anode following electrolytic corrosion has been fully established. The oxides formed occupy 2.2 times as great a volume as the original iron, and the pressure resulting from this increase of volume causes the block to crack open. The mechanical pressure developed at the iron anode surface by corrosion of the iron has been found to reach values as high as 4,700 lb. per square inch, a value more than sufficient to account for the observed phenomena of cracking. Metals which do not form insoluble products of corrosion and all non-corrodable anodes never cause cracking of the concrete as a result of the passage of an electric current.

Suggestions of some engineers that copper-coated steel, or aluminum, be used as reinforcing material have been shown to be impracticable, since the copper coating is readily destroyed and the aluminum is attacked by the alkali in the concrete.

The corrosion of iron anodes in normal concrete is very slight at temperatures below about 50 deg. Cent. The lack of corrosion of the iron at temperatures below about 50 deg. is due to the inhibiting effect of the hydrated lime, $Ca(OH)_2$, in the concrete. For any fixed temperature the amount of corrosion for a given number of ampere hours is independent of the current strength.

The rapid destruction of anode specimens at voltages from 60 to 100 volts or more is made possible mainly by the heating effect of the current, which raises the temperature above the limit mentioned above. If the specimen be artificially cooled no appreciable corrosion occurs and no cracking results.

In the specimen tested the potential gradient necessary to produce a temperature rise to 50 deg. Cent., with consequent corrosion, was about 60 volts per foot. For air-dried concrete it is much higher. This shows that under actual conditions corrosion from stray currents may be expected only under special or extreme conditions.

Since the passivity of iron in concrete is due chiefly to the calcium hydrate present it appears probable that old structures, in which the hydrate has been largely converted into the carbonate, will be more susceptible to the effect of electric current than the comparatively new concrete with which the foregoing experiments have been made. The increase in the corrosion would, however, be partly offset by the increase in the resistance of the older concrete.

The addition of a small amount of salt to concrete, as is frequently done to prevent freezing while setting, has a twofold effect. First, it greatly increases the initial conductivity of the concrete, thus allowing more current to flow, and, second, it destroys the passive condition of the iron at ordinary temperatures, thus multiplying by many hundreds of times the rate of corrosion and consequent deterioration of the concrete. Salt should, therefore, never be used in structures that may be subjected to electrolytic action. Further, reinforced concrete structures built in contact with sea

*Abstract of paper delivered before National Association of Cement Users, Pittsburg, December 10th-13th, 1912, by Mr. E. B. Rosa, Assistant Director; Mr. Burton McCollum, Associate Physicist, and Mr. O. S. Peters, Assistant Physicist, U.S. Bureau of Standards.

water or in salt marshes are very susceptible to trouble from electrolysis.

Specimens of normal concrete carrying currents increase their resistance an hundredfold or more in the course of a few weeks, which fact still further lessens danger of trouble. The rise of resistance is in general due to the precipitation of calcium carbonate within the pores of the concrete, thus plugging them up. A slight amount of salt prevents this precipitation and consequent rise of resistance, thus still further emphasizing the detrimental effect of the presence of salt.

Contrary to the observations of previous investigators, a distinct softening of the concrete near the cathode was observed. This begins at the cathode surface and slowly spreads outward, in some cases ¼ in. or more. After exposures to the air this softened layer becomes very hard again, but remains brittle and friable. This softening effect causes practically complete destruction of the bond between the reinforcing material and the concrete, reducing it to a few per cent. of its normal value. Unlike the anode effect, which becomes serious in normal concrete only on comparatively high voltages, the cathode effect developes at all voltages, the rate being roughly proportional to the voltage in a given specimen. For this reason it may frequently occur in practice, and is, therefore, a more serious matter practically than the anode effect about which so much has been heard.

The softening of the concrete at the cathode is due chiefly to the gradual concentration of sodium and potassium near the cathode by the passage of electric current. The alkali in time becomes sufficiently strong to attack the cement. This action can be increased or diminished by varying the sodium and potassium content of the cement.

Observations have shown that the softening of the concrete only takes place very close to the cathode, the main body of the concrete remaining perfectly sound without loss of strength. Because of this effect the method of protecting reinforced concrete buildings by connecting the reinforcing material as a cathode to a battery or booster would be much more dangerous than no protection at all.

The only effect which an electric current has on unreinforced concrete is to cause a migration of the water soluble elements. Consequently, in the absence of electrodes, the ultimate effect of current flow on the physical properties of the concrete is not materially different from that of flow water seepage, which also removes the water soluble elements. Non-reinforced concrete buildings are therefore immune from trouble due to stray earth currents.

Conditions do arise in practice which will cause damage from stray currents, but the danger from this source has been greatly overestimated in many quarters. While precautions are necessary under certain conditions, there is no cause for widespread alarm. Waterproofing reinforced concrete would greatly increase its resistance and diminish accordingly the danger from the anode or cathode effects. Waterproofing to prevent electrolysis is, however, a much more difficult matter than waterproofing to maintain a moderate degree of dryness, because of the much higher degree of waterproofing required in the former case. It has been found that practically all of the waterproofing agents now on the market that are intended to be mixed with the concrete are of little value as preventives of electrolysis. Waterproofing membranes, however, when applied to the surface can be made much more effective and may have considerable effect in preventing the entry of earth currents into the concrete.

Painting or otherwise coating iron with an alkali resisting metal preservative before embedding it in concrete may serve to minimize the dangers of electrolysis, but no such coating has been found that does not prevent the formation of the bond between the concrete and iron when the concrete sets. In order to insure safety from electrolysis potential gradients must be kept much lower in structures exposed to the action of salt waters, pickling baths and all solutions of chlorides, sulphates, nitrates or carbonates.

All electric power circuits within the building should be kept free from grounds directly on a portion of the building itself. If the power supply comes from a central station the local circuits should be periodically disconnected and tested for grounds and incipient defects in the insulation. In isolated plants ground detectors should be installed and the system kept free from grounds at all times.

All pipe lines entering concrete buildings should, if possible, be provided with insulating joints outside the building. If a pipe line passes through a building and continues beyond, one or more insulating joints should be placed on both sides of the building. If the potential drop around the insulated section is 8 or 10 volts or more, the insulated portion should be shunted by means of a copper cable. The grounding of electric conduits to water pipes and ground plates is in general not to be recommended in the case of concrete structures.

Lead-covered cables entering such buildings should be insulated from the concrete. Wooden or other non-metallic supports which prevent actual contact between the cable and the concrete will give sufficient insulation for this purpose. Such insulation of the lead-covered cable is desirable for the protection of the cable as well as the building.

In making a diagnosis of the cause of damage in any particular case the fact that a fairly large voltage reading may be obtained somewhere about the structure should not be taken as sufficient evidence that the trouble is due to electrolysis. The distance between the points and particularly the character of the intervening medium are of much greater importance than the mere magnitude of the voltage reading. As a precautionary measure, however, all potential readings about a reinforced concrete structure should be kept as low as possible.

SPECIFICATION FOR CEMENT TOP FLOORS.

This specification is for laying hard-finish cement top floors on new rough concrete, either paling or slabs supported by forms.

Finish to be mixed one part of cement to two parts crushed trap rock or hard gravel screening, which will pass through a half-inch sieve, and from which the fine dust has been removed. This is to be thoroughly mixed in a mixing box or by machine mixer, with an amount of water to produce a plastic but not a sloppy consistency; spread on the under-concrete before either the finish or the under-concrete has had time to set, floated with a wooden float to a true level, and then lightly troweled with a steel trowel as soon as possible to bring it to proper level, and smooth the top slightly. This will give a finish which is pebbly. It will not be dead smooth or slick like a sand finish.

After the finish has been troweled and has set sufficiently so that the covering will not mar the surface, it should be covered with sawdust, sand, cloths, or any other material which will hold water on it continuously. In building reinforced concrete work difficulty will be caused by the sand and sawdust blowing about the work, filling the forms, and generally getting in the way. In working around a textile mill there is usually plenty of old bagging, and in a paper mill there is usually plenty of old felts which can be borrowed for the purpose of preventing this.

The finish shoud be kept soaking wet for at least a week, or, better, for ten days. After two days it is possible to put up studs and do miscellaneous work on top of the new finish, provided it is not allowed to dry out.

COAST TO COAST.

Victoria, B.C.—The amount expended by the Dominion Government in dredging in the harbor of Victoria totals $84,194.21.

Calgary, Alta.—Up to Christmas, ninety-five applications had been received by the municipal authorities for the position of city engineer.

Calgary, Alta.—Permission is to be asked from the provincial government to allow Calgary to issue debentures payable in fifty years for certain purposes which include purchases of real estate, concrete structures and buildings which will come under the first-class regulations.

Ottawa, Ont.—The Department of Customs has issued an order prohibiting the importation from the New England States of forest plant products, including logs, tan bark, posts, poles, railway ties, cord wood and lumber, unless accompanied by a certificate from the United States Department of Agriculture that such products are free from the gypsy moth.

Berlin, Ont.—The report of the year's operation of the street railway shows a credit balance of $6,031.11, after taking off the debenture and interest payment. Ten per cent. was written off for depreciation on machinery, 5 per cent. on rolling stock, and 3 per cent. on trackage. This leaves a net profit of $910.58. Of that amount Waterloo is entitled to $227.64 and Berlin $682.94.

Winnipeg, Man.—According to the report just issued by the chief engineer of the Grand Trunk Pacific Railroad, on the work accomplished for the past year, construction has been undertaken on 563 miles of main line, and on 688 miles of branch lines, making a total of 1,251 miles of line on which clearing, grading, and track-laying have been done. Track has been laid on 128 miles of main line, and on 331 miles of branch lines, making a total of 459 miles of railway completed exclusive of second tracks and sidings.

Montreal, Que.—Owing to the many cases wherein expert engineering advice is required as regards level crossings, the elevation of tracks, and the construction of tunnels, the Board of Control of Montreal had under consideration recently the advisability of engaging an expert engineer for that purpose. The matter was deferred till the beginning of January, when it is most likely favorable action will be taken. Another reason for the engagement of a special engineer is that the regular staff of engineers at the city hall have practically no time to take up such work, as they have all and more than they can accomplish in keeping up with the demands for new municipal public works. Every season the city has important cases to be argued out before the Railway Commission, involving large sums of money and experience has taught the municipal authorities that the promoters have the best technical advice available. The corporation will now proceed to secure the services of an engineer who will undertake such work as the board may direct him to look after.

PRINCE RUPERT HARBOR.

It will take probably ten years to complete the work planned for the improvement of Prince Rupert harbor. Under instructions from the Grand Trunk Pacific Railway, Engineer Virgil B. Bogue has had his staff working here for several months, in preparation for making this a model harbor with its fourteen miles of length, thirty miles of water front, and a mean depth of 60 feet, without a rock or bar to interfere with navigation. Mr. Bogue plans to add civilization to its natural advantages and make a subharbor of fresh water 40 square miles in area. Between the island on which Prince Rupert is located and the main land is a large salt water lake with narrow passages at each end. Part of the general plan of harbor improvement is to put locks at the passage ways and to convert the lake into a fresh water harbor fed by mountain streams, and at high tide level. The whole water front is being laid out to accommodate berths for the big ocean liners, shipyards, fishing plants, lumber yards, saw mills, ore docks, elevators, warehouses, and other industries. The plans are sufficiently comprehensive to accommodate all the requirements of a city of several hundred thousand people.

FORESTRY AT TORONTO UNIVERSITY.

The Faculty of Forestry, University of Toronto, which graduated twelve students last year, has in the registration for the present academic year filled up its ranks to the number of 44, two old students who had interrupted their course returning and 17 new ones being registered. The graduating class has ten names, the first year of the four-year course eight names, the second year ten, and the third year five, besides eight in the six-year course in various years, and three occasional students.

Most of the graduates found employment with the Forestry Branch of the Dominion Department of the Interior, and a few with the Canadian Pacific Railway Company.

The call for foresters, owing to the sudden organization of the British Columbia Forest Branch, has been so urgent that the Dominion Branch has not been able to retain all its men, and a number have joined the new department. The market for foresters has been brisk, with consequent raises in salaries to an unusual level for young men, and altogether a hopeful development for employment is anticipated.

There have been no essential changes in the curriculum as followed hitherto, except that the practice camp has been held at the beginning of the session instead of at the end.

An unusually satisfactory location for the camp was found at Frank's Bay, Lake Nipissing, Ontario, where an old depot of the John B. Smith and Sons Lumber Company was at the disposal of the fifteen students who attended the camp, with two instructors, and a virgin stand of red pine (limits of the Strong Lumber Company), to be logged this winter, together with other types, gave excellent opportunity for practice work in forest survey, and gathering data for working plan, studying detail of types, constructing growth tables, etc.

The work was carried out according to careful plans, and has been so complete and satisfactory with regard to red pine growth studies that it is expected to publish the results.

VICTORIA'S OFFICIALS REPLY TO UNDERWRITERS.

Water Commissioner Rust and Fire Chief Davis, of Victoria, find that so far as the water situation in the city at present is concerned, the recent statements of Mr. Page, secretary of Vancouver Island Fire Underwriters, were about right, and they admit that there is a shortage of water, which shortage will be more acute during the coming summer; in fact, until water is obtained from Sooke lake. But the water commissioner is now preparing a report which will deal with the best means of augmenting the supply pending the completion of the Sooke lake development work, and this report will shortly be before the council.

They correct Mr. Page's statement that the fire department has been in the practice of connecting fire engines to the salt water hydrants. It was only done on one occasion, about two years ago, but the standing order now is that this must

not occur. Also, relative to the department's telephone service, the department lines are operated under a separate exchange system in headquarters station, with a private wire for fire alarms only. Further, Mr. Page's suggestion that a fire alarm wire to the North Dairy Farm pumping station is required has been adopted, and the line is about completed.

The officials' report also states that it is the intention of the water commissioner not to construct any more four-inch mains except occasionally on streets whereon there are a number of houses and in the outskirts of the city.

In answer to a question, Fire Chief Davis stated that for the past two months the pressure available for fire fighting purposes in Victoria West has been good. At the Victoria West fire hall, which is about the highest point in that section, the pressure has been maintained at from fifty-five to sixty pounds and has not been less, while on the low level the pressures range from ninety to ninety-five pounds, and have run as high as 105 pounds. This improvement has occurred since the Esquimalt Water Works Company installed its new main to Goldstream. About two months ago while repairs to the pipe line were being made, the supply was gradually reduced during the day, with the result that the pressure had been reduced to about twenty-five pounds.

ST. LAURENT AND MOUNT ROYAL FRANCHISES.

An ending somewhat characteristic of present-day developments has taken place in the case of the franchise for the public service of the municipality of St. Laurent and the disagreement between that municipality and the new Model City of the Canadian Northern Railway. It may be recalled that the Franco-Belgian Syndicate some time since obtained the franchise for the supply of water for the town but refused to post the deposit of $20,000, being no doubt desirous of obtaining the franchises for all the public services. Later, the council granted franchises for water supply, lighting and street railway service to the company, the conditions being that the franchise was for twenty-five years, work on the waterworks and on lighting to be commenced within thirty days of notice from the council, and the railway to be commenced within six months of the adoption of the by-law now before the legislature at Quebec.

The Franco-Belgian Syndicate only had a capital of $100,000, but was applying to the Dominion Government for an increase to $2,000,000, and the representatives of the company claimed they had lots of French and Belgian capital behind them and were well able to post their $50,000 deposit.

It was a little significant that the Montreal Tramways Co. was not making a very strong agitation against the granting of the franchise, so far as known. When the matter came up before the Quebec legislature, it developed that the Franco-Belgian Syndicate had turned over its franchise for street car service to the Montreal Tramways Company and its lighting franchise to the Montreal Public Service Corporation. These concerns are those with which Mr. E. A. Robert, M.L.A., is particularly interested and which are included as subsidiaries in the Montreal Tramways and Power Company. It was suggested that Mr. Robert should not vote in the matter when it came up at Quebec, but the point was not pressed for the reason that the government had a large majority in any case.

In the above connection, also, the legislature sanctioned a twenty-five year franchise for the Montreal Tramways Co. for the street car service for the Canadian Northern Railway "Model City," the name of which town was changed at the same sitting of the legislature to "Mount Royal." Also, at the same meeting, a fifteen-year franchise was given the Montreal Public Service Corporation for the lighting of the streets of Mount Royal. The counsel for the Montreal Light, Heat and Power Co. was on hand to object to this on various grounds, among which was the fact that no one yet lived in Mount Royal. He claimed that it was a shame that this company should get the exclusive franchise in this manner when there were so many other companies in the field. The answer made to this remark by the friends of the bill was that the Montreal Light, Heat and Power Co. should have thought of this when they were getting their privileges in 1901 and that if they were prepared to give up their exclusive franchises the other companies were prepared to do the same.

As a result of the final revision made by the private bills committee of the legislative assembly, the Montreal Tramways Company, and allied interests, abandoned their exclusive franchise for the construction of a water works system in the parish of St. Laurent, and retained the exclusive franchises for the tramways service, and the supply of electric light and power. These franchises are for the period of twenty-five years each. The protests of the electors of the parish of St. Laurent and the vote they had taken against the water works privilege being limited to one company, were not commented on in any way.

The legal representative of the company, Mr. Rinfret, moved that the reference to the water works by-law, which the bill asked to be sanctioned with the two other by-laws, be omitted, and this was followed by the further amendment, also included in the bill of Mount Royal in favor of the protection of vested rights.

Honorable Mr. de Varennes, chairman of the committee, inquired whether the representative of the parish of St. Laurent consented to the change, and Mr. Jasmine nodded consent.

The Vancouver board of trade is taking up matters of material benefit to the province as a whole, one of which is the question of securing actual settlers for the land. There has been criticism of the manner in which the land resources of the province have been administered, and the board of trade committee have had the matter under consideration for months. The substance of its report is that care should be taken to exclude the speculator, to encourage the settler and to help the man who would till the soil, practical assistance being given by the government.

PERSONAL.

R. A. ROSS, consulting engineer, of Montreal, has been engaged by the city of Calgary to make a report on the local power and light situation.

H. A. BAYFIELD, government superintendent of dredging in British Columbia, has been relieved of his duties by the Minister of Public Works.

ALEXANDER POTTER, consulting engineer, New York, has changed his address from 114 Liberty Street to 50 Church Street, New York City.

H. BARBER has resigned from the Hydro-Electric Department of the city of Hamilton to take a position with the Toronto Hydro-Electric Commission. Mr. Barber is a graduate of the Toronto University in Electrical Engineering.

JOSEPH D. EVANS, who has been chief engineer of the Montreal Tramways Company since June, 1911, will sever his connection with that company on January 1, and become construction manager of the Electric Bond and Share Company, of New York, one of the largest builders and operators of public utilities on the continent.

J. W. TYRRELL, one of the first graduates of the School of Practical Science, has formed a new consulting engineering firm in Hamilton, Ont. The members of the

firm are J. W. Tyrrell, John E. Jackson and Oliver E. Blandy, and the work taken up will be civil engineering, and Ontario and Dominion land surveys. The offices are in the Hamilton Provident and Loan Company.

W. P. NEAR, B.A.Sc., has been appointed city engineer of St. Catharines, to take the place of Mr. R. D. Brown, whose resignation was noted in these columns some weeks ago. Mr. Near was born in St. Mary's, Ont. He was educated in the High School there, and later graduated in civil engineering from the University of Toronto. He worked on boundary surveys in Alaska, and later spent a year on the Temiskaming and Northern Ontario Railway. The year 1905 witnessed the eclipse expedition to Labrador and Mr. Near was a member of the party. Three and a half years ago he joined the main drainage department as a member of the Toronto city engineering staff.

COMING MEETINGS.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annua Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre: Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack: Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES—President, George Thompson, Indian Head, Sask.: Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer. J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

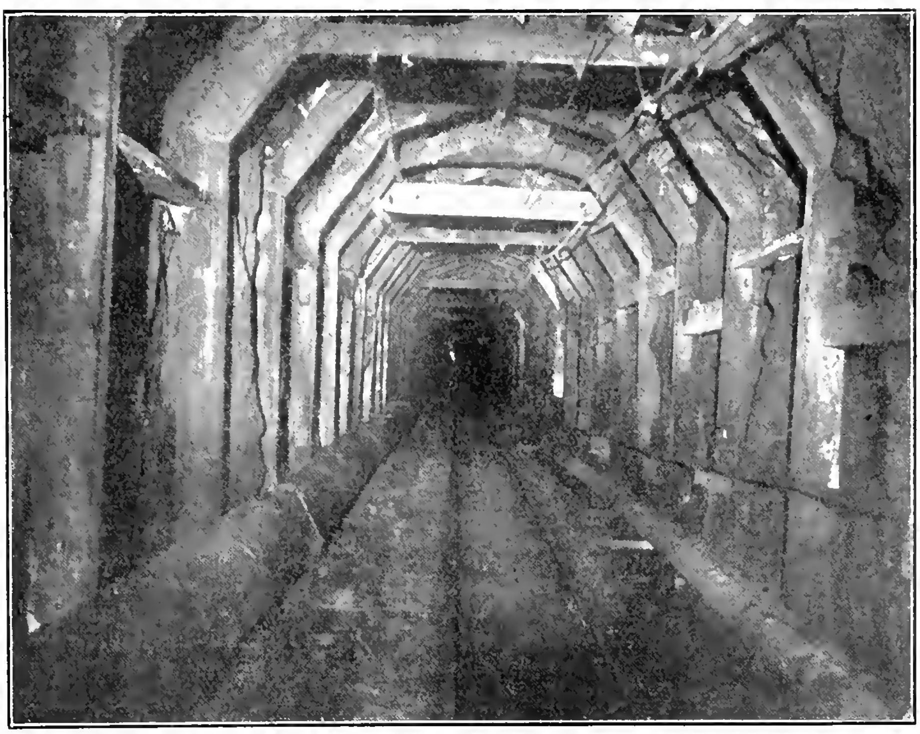
Volume 24. Toronto, Jan. 9, 1913 Contents of this issue on page 147

The Canadian Engineer

An Engineering Weekly

THE FINAL COMPLETION AND OPERATION OF THE LOS ANGELES AQUEDUCT.

The Los Angeles aqueduct, which for the past eight years has been under construction, is now nearing completion. Late in February the system should be completed and ready for operation. The enterprise has excited international attention; first, because of its magnitude; second, by reason of the unusual difficulties of operation which have been overcome; third, that with the exception of one comparatively small contract, all the work has been done by the municipality itself; fourth, that it is a public work which will be completed in advance of the time for which it was promised and at a cost well within the original estimate; fifth, the great economic value of the water for irrigation and domestic use and the development of hydro-electric power. In the following paragraphs each of these features will be discussed briefly, the object being to give a general description of the whole work, the economies of construction which have been worked out on a large scale and the economic importance of the enterprise to the whole of Southern California.



Interior of Elizabeth Tunnel.

(Photograph taken 2½ miles within the tunnel. Point of light in centre of picture is north portal of the tunnel)

The city of Los Angeles, a municipality of 400,000 population and growing at the rate of 40,000 per year, in 1904 was confronted by a diminishing water supply, at present obtained from the surface and subterranean flow of a stream called the Los Angeles River. No municipality has greater need for an abundant water supply, for it is situated in a semi-arid region where the average precipitation does not exceed 15.67 inches annually and no rain falls from April to the last of October. The per capita consumption of Los Angeles is 140 gallons daily; the daily per capita consumption of London amounts to only 28 gallons.

After federal and Los Angeles engineers had investigated the conditions for a period extending over several years, the nearest adequate source of supplementary supply was found to lie in the Owens River, a stream draining the eastern face of the Sierra Nevada Range which forms the roof-shed of the United States. To this source the city has gone. Purchasing 120 square miles of territory in the Owens Valley and with the active co-operation of the United States government in the way of public lands and helpful legislation, Los Angeles has undertaken to carry a daily supply of 280,000,000 gallons from this source into the Fernando Valley, at the mouth of which the city is situated.

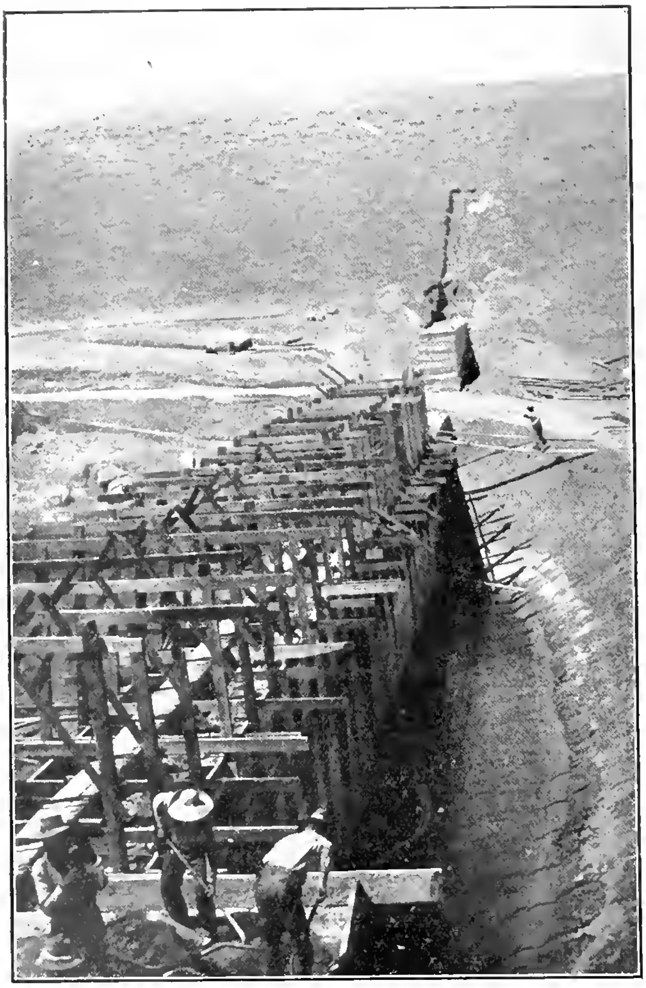
To accomplish her purpose the city is constructing a concrete aqueduct across the great Mojave Desert and under the Coast Range (Sierra Madre) of mountains. The aqueduct is reinforced by an extensive system of storage and regulating reservoirs. The length of the aqueduct from the intake to the impounding reservoir at the outlet is 234 miles. From the latter point the water will be distributed for irrigation or carried 10 miles further through steel force mains to be connected with the city's present waterworks. The system is gravity throughout. The intake is 3,812 feet above sea level; the outlet of the lowest reservoir is at elevation 1,020 and the elevation of the Los Angeles city hall is 276 feet above sea level. The total estimated cost of the aqueduct proper, exclusive of other features yet to be discussed, is $24,500,000. This, in a word, is the Los Angeles aqueduct, or, as it is quite popularly known, the Owens River project.

The economic value of the aqueduct lies in the fact that it will provide domestic water for 1,000,000 people; through

a municipal irrigation system irrigate 135,000 acres of land surrounding the city, and from its 1,500 feet of fall develop a maximum of 120,000 horse-power of electrical energy, for which funds have already been partially provided.

The foregoing briefly explains the impelling motives of the city in undertaking a work of such magnitude and the ultimate possibilities of the project. It is similar to the Panama Canal in that it is without a parallel in history.

It must be remembered that Los Angeles, to accomplish her purpose, went into a naked desert and among high and desolate mountains—a country practically devoid of habitation, fuel or water. The work of preparation in point of the spectacular outrivals the actual construction.



Building the Concrete Core-Wall of the Fairmount Reservoir.

Only the bare outlines can be given here, but the preparatory features included the construction of a standard gauge steam railroad 142 miles in length by the Southern Pacific Railroad Corporation, which secured thereby the hauling of the 20,000,000 ton miles of freight; the building of 315 miles of mountain roads and trails costing 260,000; the installation of three water systems comprising four reservoirs and 150 miles of mains at a cost of $350,000; the building of a municipal copper line of telephone system with 460 miles of lines and costing $75,000; the erection of three hydro-electric power houses and 268 miles of high-tension transmission line to furnish motive energy and light along the aqueduct zone at a cost of $450,000; the construction of a large number of structures of all classes and description for men, animals and machinery; and, finally the purchase of clay and limestone deposits and the erection of a municipal Portland cement mill with two auxiliary tufa grinding mills at a cost of $800,000. A little over $4,000,000 was expended before the work of aqueduct excavation was even started.

Since June of 1909, the excavation has continued at a rate exceeding 50 miles per year. To-day the excavation totals 220 miles. (This is approximate on the date at which I write—December 7th). Much of it has already been tested wherever water has been obtainable, and while no official date has been set for the dedication of the work, March 1st should see the finishing touches completed.

A tabulation showing the classification of the work, together with the total footage, is as follows:—

Classification.	Total footage.
Tunnel	42.69 miles
Power tunnel	9.23 "
Open unlined canal	21.14 "
Open lined conduit	39.56 "
Concrete-covered conduit	97.72 "
Haiwee By-Pass	1.92 "
Siphons (steel and concrete)	12.06 "
Flumes	.17 "
Power penstock	.44 "
Other power construction	.30 "
Reservoirs	8.5 "

Total length of aqueduct system 233.73 miles

The original design of the aqueduct, if the power was not developed, called for the use of the natural bed of the San Francisquito Canon for a distance of about 12 miles. Owing to the large asset in the power feature, hydro-electric power is to be developed simultaneously with the completion of the aqueduct so that instead of being permitted to follow the stream channel the water will be carried along the rim of the canon. This construction has been denominated as "Power" in the above classification and has been undertaken conjointly by the aqueduct and power bureaux, each bearing their pro rata of the expense. Denominated as "Division No. 14," this work was left to the last, as bonds for power construction were not voted until late in 1910. Otherwise the aqueduct might have been completed some months earlier than the date now set. Construction on this section was begun in August of 1911 and the last of the tunnels should be excavated shortly after the first of the year.

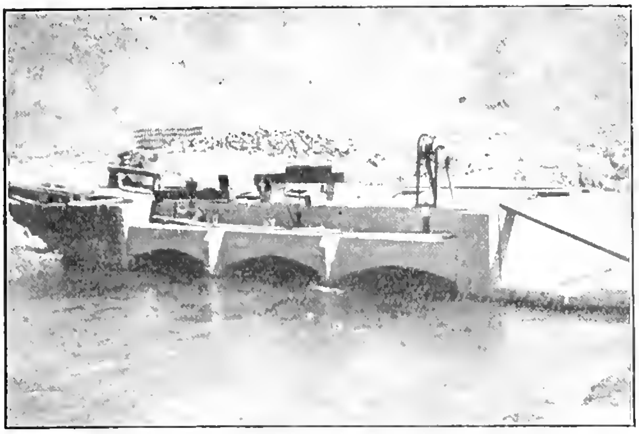
The system of reservoirs which is now under construction is one of the largest in existence. The Round Valley reservoir, with an impounding capacity of 340,890 acre feet, which will be situated 50 miles above the intake, will not be constructed until after the aqueduct is in operation. It has been designed solely for the storage of heavy years of precipitation as a safeguard against years of drought. The other reservoirs of the system are under construction and are as follows:—

Name.	Acre feet.
Haiwee	63,800
Fairmont	7,620
Dry Canon	1,325
Fernando (Lower)	25,000

Of the foregoing the Dry Canon reservoir is completed, the Haiwee is practically completed, while the Fairmont and the Fernando are well under construction. The dam of the Lower Fernando will be 700 feet wide at the base, 7,320 feet in length, 130 feet in height, and the fill amounts to 2,700,000 cubic yards. It is being built by sluicing and exclusive of the Gatun dam of the Panama Canal, will be the largest hydraulic filled dam in existence. This reservoir is at the terminus of the aqueduct and is calculated to afford four months' supply for one million population. Two other

large reservoir sites have been surveyed as a part of the general plan of irrigation, but no work has as yet been undertaken on their construction.

The most important phase of the work, in fact one of the controlling factors in the completion of the aqueduct, was the Elizabeth Tunnel. This tunnel was "holed" March 1st, 1911, nearly a year in advance of the estimated time required for its excavation. This tunnel, the second longest water tunnel in the United States, was driven 26,870 feet through the hard gneiss rock of the Sierra Madre range in



The Intake of the Los Angeles Aqueduct, Eleven Miles North of Independence, California.

the short space of 1,240 working days. The average rate of progress from each portal was approximately 12.36 feet per day. United States tunnel records were repeatedly broken, that of 449 lineal feet in a thirty-day month from a single heading being advanced to 604 feet for the same interval. The work was carried on continuously in three eight-hour shifts from opposite sides of the range, the excavation being accomplished with Leyner drills driven by compressed air, and the muck handled by electric motor railways. Throughout the task, the work, excepting at the very start, when crude methods were adopted until the arrival of proper machinery, the most modern electrical equipment was used. The underground and surface forces at each portal averaged 100 men throughout the drilling. From the north portal the progress was made exceedingly difficult by water pockets and swelling earth, and heavy timbering was required. From the north portal 13,500 feet were driven and from the south portal 13,370 feet. The centre lines of the tunnel met within 1⅛ inches and the grades checked to five-eighths inches. The estimate of cost for the completed tunnel was $75 per lineal foot, or $2,015,250. The actual cost of boring and concreting has been $50.69 per foot, or a total of $1,362,040, which is $653,210 below the amount set aside for the purpose. Concreting is now nearing completion.

Including the construction of the Elizabeth Tunnel, the tunnel work of the aqueduct until the first of this year has progressed at an average rate of one mile of tunnel excavation per month.

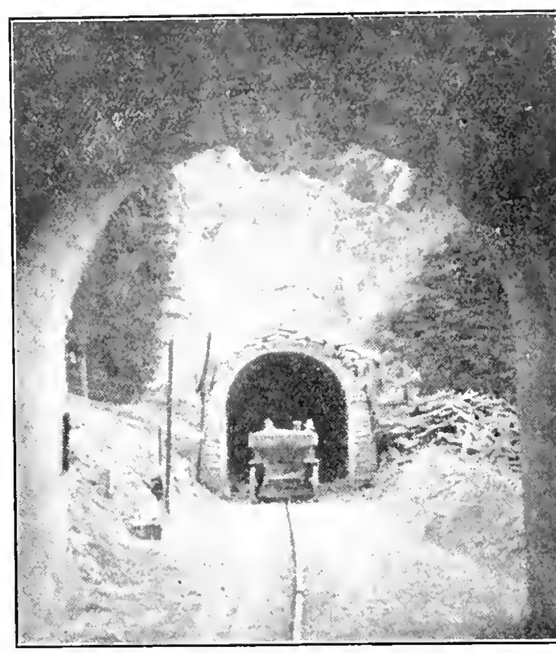
The mechanical excavating equipment for conduit and canal excavation consists of two powerful electric dredges which have now completed their work in the Owens Valley, 13 steam and electric power shovels and one giant excavator. The labor force has ranged from 2,500 to 4,300 men, during the summer season it being difficult to obtain laborers who were willing to go out on the desert.

The hospital department, as well as the commissary were let by contract, the city receiving no financial return and having the privilege of terminating the contracts upon 30 days notice if the city's standard of board, medical and sanitary care of men and camps is lowered. The men pay $1 per month for medical attendance and board is furnished at the rate of 30 cents per meal. Rates of pay for day labor have ranged from $2 to $2.75 for eight hours' work, depending upon the labor market as well as the character of the labor. Miners and mechanics have received from $3.50 to $3.75 for eight-hour shifts and formen $3.50 to $4.50 per day.

With the exception of one small contract representing three per cent. in point of distance and which was in easy construction, all the work has been done directly by city forces from engineers down to day laborers.

On this work, also, the city of Los Angeles for the first time in American municipal history inaugurated the bonus system of payment. Its success surpassed the most sanguine expectations of the city's engineers. Whether it is in conduit excavation, concrete lining, tunnel boring, siphon building or whatnot, the chief engineer sets as a basis of bonus payment, dependent upon the classification of the particular piece of work, the average progress that should be made by the crew or gang in a ten-day period. For all in excess of this amount, each man participating in the work, in addition to his daily wage, is paid an established sum proportionate to the progress made. On the Elizabeth tunnel, for example, miners were accustomed to receive monthly pay-checks which, with their bonus, ranged from $140 to $170, and muckers and other laborers' checks were in proportion.

This system has brought out the best that was in every man because, in the hope of personal reward, there has been an incentive for him to do his best. Moreover, it created a rivalry between each of the fifty camps and brought an organization of unusually high efficiency. As drones retarded



Showing Completed Tunnels.

the work, delayed progress and so cut down the bonus payment, the workers of their own accord drove out the drones. The working out and development of the system has excited a great amount of interest from engineering publications, engineers and municipal officials throughout the United States.

Another phase of unusual municipal activity in connection with this enterprise has been the building and operation of cement mills and the introduction and use of tufa cement. In this phase of the undertaking, $875,000 of the public

funds were expended. The Portland cement mill was erected at Monolith, close to the line of the aqueduct, about equidistant from the intake and outlet, adjacent to large deposits of limestone and clay and with transportation facilities that have reduced freight rates to a minimum. This mill was first fired in March, 1909, and with a capacity of 1,000 barrels per day, to January, 1, 1912, had ground 575,000 barrels.

It was found that at Monolith and two other points in close proximity to the aqueduct line there were large deposits of tufa strikingly similar to the Italian tufas used in the construction of the Coliseum and the Roman aqueducts. Tufa is a volcanic ash metamorphosed by volcanic heat and water into a white, brittle, porous rock. A year of tests and experiments demonstrated that an excellent cement could be manufactured by taking equal amounts by volume of Portland cement and ground tufa and regrinding them to a fineness of not less than 90 per cent. passing a 200 mesh screen. The seven-day test shows to the advantage of the Portland, but after that the tufa cement surpasses the Portland in breaking strength and at the end of one year, exceeds Portland by about 20 per cent. In 1909-10, therefore, tufa grinding mills with an aggregate daily capacity of 2,600 barrels were erected on the sites of the deposits.

Building a Concrete Siphon.

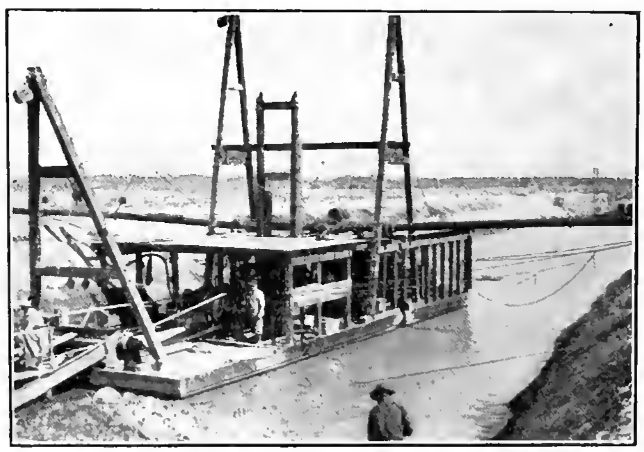
The advantage of this municipal move will be seen in a comparison of cement prices. At the time aqueduct work was started, commercial cement sold in the Los Angeles market at $2.25 per barrel. The city has been able to manufacture her own Portland cement at a cost of approximately $1.30 per barrel and the tufa cement at from 83 cents to 86 cents per barrel, besides reducing freight charges fully fifty per cent. by having two of the tufa mills directly on the aqueduct where the material was to be used. Now that the aqueduct is nearing completion the tufa mill machinery will probably be disposed of to the federal government, while it is possible that the Portland mill may be retained to furnish cement for other large public works now underway.

At the time this is being written, the most interesting phase of construction is the fabrication of the inverted steel siphons by which the waters of the aqueduct are to be carried across canons and valleys. So far as the writer knows, these huge steel pipes are the largest and longest in existence. They range in length from 611 to 15,596 feet, and in diameter from 8 feet 6 inches to 11 feet. The thickness of the steel varies from one-fourth inch to one and one-eighth inches. The aggregate length is 49,576 feet, the cost of which installed represents an expenditure of $1,400,000. The total tonnage amounts to 14,500 tons. These siphons will be under heads ranging from 75 to 450 feet.

The siphons are all of single plate construction. The material is furnished under contract and the work of erection is performed by the city. No foundry on the Pacific Coast was equal to the magnitude of the task. The plates are therefore rolled, punched and bevel-sheared, under the eyes of Los Angeles inspectors, in the steel foundries of Pittsburgh, Pa., and Camden, N.J. There they are erected section by section, given a number on a diagram showing the exact location of every plate and rivet hole in the completed structure, are then taken apart, nested on flat cars and dispatched to the railroad station nearest the point of their destination on the Mojave Desert. From here they are freighted by twelve mule team wagons from 5 to a maximum of 30 miles to the point of erection where the diagrams have already preceded them. Here they are lifted by aerial trams to their place along the canon wall and are riveted into place. Twenty-four-inch double disk gate valves are placed at the lowest points of the siphons, first, for cleaning purposes, and secondly, to divert the flow of the aqueduct into natural water channels should a break occur in the conduit high along the mountainside to the south of them. This work is proceeding simultaneously at seven different points and should be completed during the second week in January.

Where the head is low, concrete siphons are used in place of steel on account of the cheaper cost. These pipes, used also in the approaches to the steel siphons, are 10 feet in diameter, strongly reinforced with steel and constructed of very rich cement. The illustration shows the manner of reinforcing.

For the partial development of the hydro-electric power, the city voted $3,500,000 in the spring of 1910. While the aqueduct is being built primarily for a domestic water supply this feature in point of revenue is by far the most important. The Board of Electrical Engineers reported in 1910 that a maximum of 99,000 kilowatts, or 120,000 horse-power, can be generated from the aqueduct with all conditions present for reliability of service and favorable low costs of operation. Owing to the regular and assured flow through the aqueduct, they reported that in their opinion no reserve steam plants are necessary and that from this and other favorable conditions, one of which is that the major part of the electric energy can be developed in close proximity to



One of the Hydraulic Dredges at Work Near the Intake of the Aqueduct.

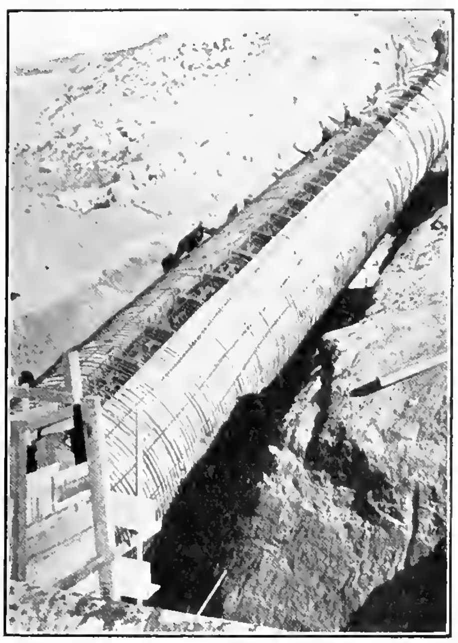
the city, the cost delivered at the Los Angeles city limits will not exceed $60 per horse-power. This is much less than the cost at which hydraulic power is at present developed on the Pacific Coast.

The plans call ultimately for the operation of seven power houses, two of which, Division Creek and Cottonwood, are now in service as construction plants.

These plants are as follows:

Name.	Maximum net head.	Kilowatts at switch board max. flow max. head.	Length of transmission line to Los Angeles.
Division Creek	1,210	600	225
Cottonwood, No. 1	1,218	1,500	185
Cottonwood, No. 2	2,065	2,500	190
Haiwee	182	4,590	162
San Francisquito, No. 1	905	51,750	47
San Francisquito, No. 2	512	32,000	40
San Fernando	281	7,225	21
Los Angeles sub-station		90,000	

(11 per cent. transmission loss, including step-up and step-down transforming)

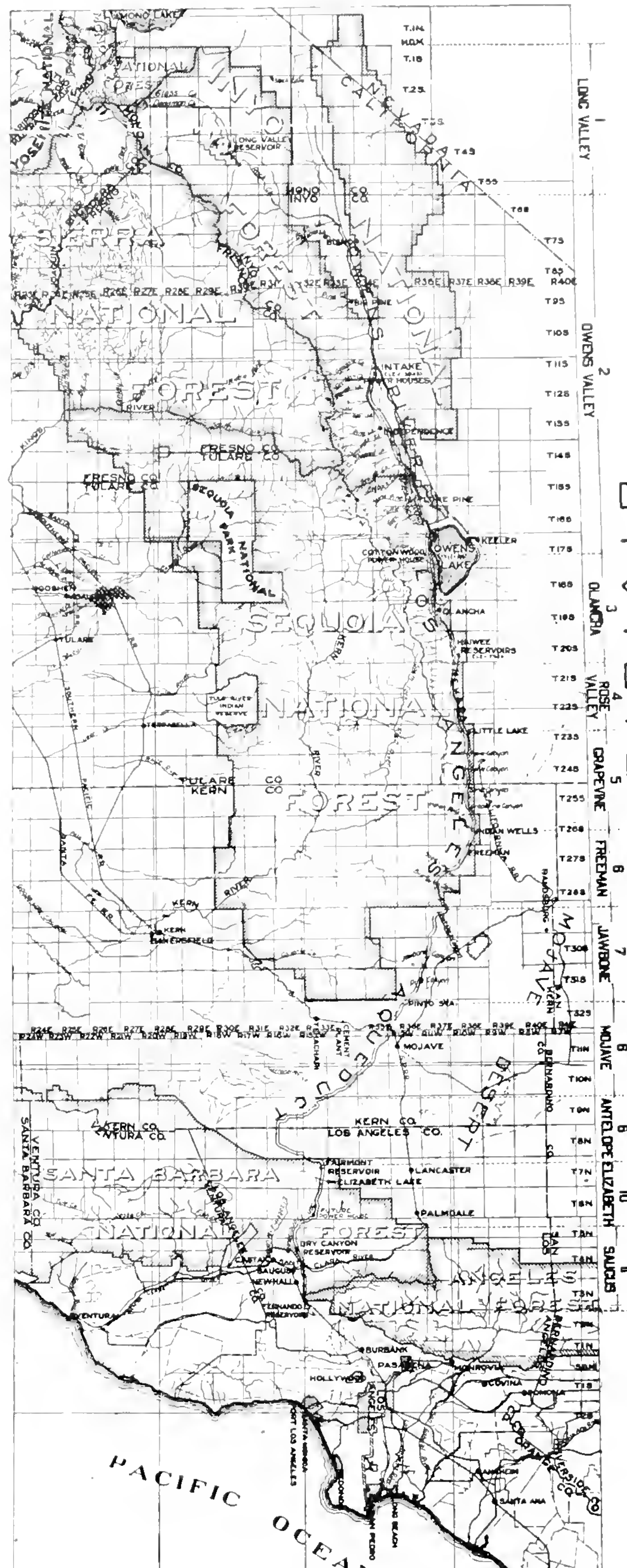


Constructing One of the Concrete Siphons.

Plans for the partial development of power house No. 1 in San Francisquito canon are now ready for the construction department. Contracts have been let to the Union Iron Works and the Westinghouse Company for machinery to cost $300,000 with delivery to be completed by January 1st, when the buildings will be ready to receive it. This plant will have a capacity of 37,500 horse-power and is scheduled to be complete and ready for operation in April of 1913. Other units of power will be installed as a market for the product develops.

Whether the power will be disposed of to the Los Angeles power companies at a wholesale rate or a $5,500,000 distribution system built by the municipality remains to be voted upon by the people, whose attitude at the present time is strongly in favor of the latter alternative.

Irrigation, the last subject to be discussed, is second only to power development from a financial standpoint. It must be kept firmly in mind that Los Angeles lies within a semi-arid region, where land values are directly proportionate to the accessibility of water for irrigation. This is shown by the fact that lands which will be watered by the aqueduct,



Map of the Los Angeles Aqueduct and Adjacent Territory.

as dry land sold from $20 to $50 per acre seven years ago and to-day are being sold from $350 to $500 per acre.

Approximately 225,000 acres of land for which little water is now available lie within a radius of 30 miles of the municipality. The surplus waters of the aqueduct will supply irrigation for 135,000 acres of this amount, allowing for the return of 2,000 miner's inches by seepage into the city's present infiltration galleries, provided the Fernando Valley is given irrigation.

Studies by the Los Angeles Water Department show that it requires the same amount of water to irrigate an acre of citrus trees that is required for an acre given up to urban population. The city, in its remarkable growth, is constantly encroaching on urban lands. The very nice problem enters of applying the water for irrigation in the localities which will gradually and insensibly grow from suburban into urban territory with the accompanying gradual transfer of the water from irrigation to domestic use.

For the past year a corps of engineers have been working on this problem. The irrigation system will therefore probably differ from the concrete canal systems found in California in that it will consist of large steel pressure mains ranging from 4 to 6 feet in diameter leading off from the Fernando reservoir to water the country below it. Probably the plan adopted by the United States Reclamation Service of forming irrigation districts will be put in force. In this event the districts will be required to defray the cost of all the work which will be installed by city engineers and become the property of the city. The actual cost to the irrigators has not been fixed, but the average annual rental for water in Southern California is approximately $10 per acre.

With all the available water power developed and with the surplus water disposed of for irrigation, Mr. J. B. Lippincott, assistant chief engineer of the aqueduct, has computed that for a total expenditure of $31,500,000 Los Angeles will receive a net annual income of $4,425,000, which is the equivalent of 5 per cent. interest on $88,500,000.

In conclusion, this project, now on the eve of completion, stands out clearly as the foremost municipal engineering achievement of history. It is an enterprise of which a nation might well be proud. In its large conception, its building by city forces, and its promise of large economic returns, this project certainly is one that is destined to have a very vital influence upon many other cities of America where the clamor for the ownership and operation of public utilities grows constantly louder.

OCTOBER RAILWAY TRAFFIC EXCEEDS ALL RECORDS.

The receipts and expenses of the steam railways for the month of October, 1912, are greater than for any other month in their history. Net operating revenue, which is the gross income before anything has been taken out for taxes and rentals, interest on bonds, appropriations for betterments or dividends, averaged $15.71 per mile of line per day, which contrasts with $13.74 for October, 1911, an increase of $1.97. This is an increase per mile of line for the month of $61.13, or 14.4 per cent.

The monthly summary of the Bureau of Railway Economics, compiled from the reports of railways to the Interstate Commerce Commission, covers for October 220,636 miles of line, or about 90 per cent. of all of the steam railway mileage of the United States. The aggregate net operating revenue for this mileage was $107,440,518, which is greater by $14,870,125 than that for October, 1911. The increases were due in greatest proportion to the freight traffic, which is always greater in October than in any other month of the year.

GOOD ROADS IN ALBERTA.*

By J. D. Robertson.†

The Local Improvement Organization, and works, done under this organization, have not, in all cases, been satisfactory. Many reasons have contributed to this, one being that the works facing such organizations were of such a character and magnitude that the funds at their disposal were not sufficient to cope with the situation. Another cause has been the fact that earth roads, when once built, in many parts of the Province require so much in the way of maintenance that little of value has been accomplished. The system of commuting taxes by labor has not, in my opinion, contributed much to the improvement of roads, but instead established a system which, while necessary in the new and sparsely settled districts, has frequently been continued after settlement was more dense, when vastly better work could have been accomplished by collecting the money and employing some capable man as foreman to conduct the work under the direction of the Council. The system of each Councillor having charge of the expenditure of all money in his particular division or township, regardless of main road requirements, without any comprehensive plan approved by the whole Council, has resulted in disconnected pieces of works here and there without much continuity of purpose.

Another matter might also be mentioned, which has not, in our opinion, contributed very largely to the improvement of roads, is the fact that the rate of assessment may be placed at anything from one and one-quarter cents to five cents per acre. We find certain districts, since their organization, assessing to the limit, while others, in which works are quite as necessary, assessing at the lowest figure, or very close to it. In other words, one man will pay $8, local improvement taxes, on one quarter section, while perhaps his neighbor, who is using the same roads, is paying only $2 per quarter section, which, to our mind, is certainly not just, and it is noted, in sections of the country where only the one and one-quarter cent per acre or $2 per quarter is levied, they are quite as persistent in their requests for Government assistance as where they are assessing themselves to the limit. Under such conditions the Local Improvement Organization could not be expected to receive the hearty co-operation of the Department that it deserves. It is to be hoped that some of these difficulties and drawbacks will be removed under the Municipal Organization, where such is put in force, and also under the re-organization of Local Improvements Districts, where municipalities are not formed. It should be mentioned here that, while certain districts have been handicapped by the difficulties mentioned above, others have taken the best out of the Act, under which they are working, and have achieved very satisfactory results. In conducting work for the Government, on the improvement of roads, we are well aware of the many difficulties to be contended with, and it is to be hoped, when another year's work is begun, that we may have an even more hearty co-operation with the new organizations than it has been possible to have under the old regime. In most of the Province the building of permanent highways is still in the distance, and, for this reason, I am going to confine my remarks to the more primitive works.

Grading Earth Roads.—The fact should always be borne in mind that water from melting snow or ice and rain is the principal factor against which we have always

* Address delivered before Alberta Local Improvement Districts Association, Edmonton, Alta., November 26th and 27th, 1912.

† Provincial Engineer of Highways of Alberta.

to contend in the construction and maintenance of earth roads, water on the surface causing clay or loam roads, even under light traffic, to work up into an impassable condition, and, during long continued wet weather or under heavy traffic, such roads will always be bad, though their unsatisfactory condition may be minimized greatly by first building them up to a rounding surface with grader, then maintaining their surface by frequently dragging to fill ruts, caused by wheel traffic, so the water will run off instead of lodging in them and soaking into the road, causing the mudholes so often encountered on earth roads. The split log drag, or several types of similar implements working on the same principle, have been found very effective and economical in maintaining such roads, costing about one-third as much as a blade grader to trim up rutted roads, and, in many cases, doing quite as efficient work. In many parts of the Province the heavy clay loam, so desirable for agricultural purposes, is a most unsatisfactory road material, will not carry heavy traffic when dry, and absorbs water freely in wet weather, with the result that such roads go to pieces. In some parts of the Province gravel is available for top dressing, and, when within a reasonable distance, makes a great improvement for a time, but soon works down into the clay, when the process must be repeated. A top dressing of sand has been experimented with on heavy clay roads and found to give very satisfactory results, but this, like the gravel, soon becomes mixed with the clay, when another coat of the same material is required. Frequently neither gravel or sand are obtainable within a reasonable distance, and are sandy or gritty subsoil, frequently found and exposed by the ditches along roads, generally upon hills or slight elevations, provides a top dressing far superior to the natural clay loam, some of it packing and binding very satisfactorily under wheel traffic, and forming a roadbed quite impervious to water, and since macadam and the many types of asphalt are probably, owing to their cost at the present time, out of our reach, a great improvement might be made on country roads by making the best use of material available.

Draining to Prevent Seepage of Water from Side Ditches Into the Roads.—This, in many places, is of more importance than raising the road by grading, and frequently costs less. It will be noticed, where pools of water are allowed to lie in the ditch alongside of roads, that the road frequently breaks down into impassable mud holes. This is caused by the seepage of water into or through the road bed. In many cases such water can easily be drained along the side of road, or away from it, at a less cost than fixing the mud holes by raising the road after the water has caused the damage. Grading the bottoms of ditches, so water will drain off, is quite as important as grading the surface of road, but, considering that it is a common practice all over the Province to pasture cattle on the road allowance, where the ground is soft and ditches necessary, they are soon tramped in, damming up water and undoing the work that has cost large sums of money. If the owners of cattle, grazing on the roads, were compelled to repair the damage done by them, in wet country where drainage is necessary, the revenue for road improvements might be considerably increased. Considerable damage is also done tramping down the approaches to bridges and culverts, and I never knew of it occurring to the owner of a large or small herd of cattle, that anyone but the public should contribute to the improvements made necessary by his grazing them on the roads. Of course, in certain parts of the country, where there is vacant or unfenced land, it is difficult or impossible to prevent such damage, though in other parts, where well fenced, the highway is considered a convenient public pasture. Proper ditching, on hills or hillsides to carry off the water and prevent it running down the wheel tracks and destroying the road in many parts of the country, receives but scant attention. I have observed many hills, where a road had been well constructed and properly ditched, where immense damage had been done by water running down upon it, when a few dollars spent keeping the drains open would have avoided considerable loss and inconvenience caused by an impassable road, and in this respect I would ask for the hearty cooperation of the Local Improvement District to keep such ditches open. Before closing my remarks on primitive earth roads, I would like to say a few words with reference to the use of brush, where such is available, for a corduroy or bottom on wet or springy ground. It frequently happened, where such is required, that nature has provided brush in the immediate locality, the very nature of the soil causing a growth of willow, and, where such exists, and frequently has to be cleared from the road, it is a good practice to use it for a brush mat in wet places, covering this again with the best material available, when a foundation will be provided for a road that should be passable even in bad weather, while, without brush or corduroy, raising a grade with the material available frequently results in simply adding to the depth of mud to be travelled through. In certain parts of the Province, where the country is wet and drainage not feasible, too much attention cannot be attached to this precaution. Another practice sometimes followed is to grade roads through low wet ground, sloughs and potholes, during dry weather, without much provision to drain the water off, when it turns wet, or, at least, to control it so it will not rise over the road. Large amounts of money have been spent grading such roads in this Province, that were lost when the weather turned wet and the sloughs and potholes filled up with water. When it is not feasible to put in drainage, to at least control the raise of water, and the high water mark is in evidence, and money is not available to raise the grade above such high water mark, then the obstruction should be gone around, otherwise the money put into it is pretty certain, sooner or later, to be lost. There is a very general impression, in the minds of the public, that statutory road allowances, as laid out under our system of sub-division, should be followed regardless of physical difficulties, which is entirely erroneous, and results in an attempt being made to grade down impassable hills, and to grade roads over ground quite unsuitable for road purposes, that might and should be gone around. In the older Provinces the system of survey differed from ours, and the Crown reserved a certain percentage from all lands for such purposes. Our old trails, in many localities, illustrate what we might have had, in the way of roads, where the contour of the country is more generally followed. While on level prairie it is generally quite feasible to follow road allowances, the same system is quite unsatisfactory in rough or broken country, and a very sincere effort should be made to overcome the objections of the owners of lands, where such diversions are necessary so a permanent and safe road may be established.

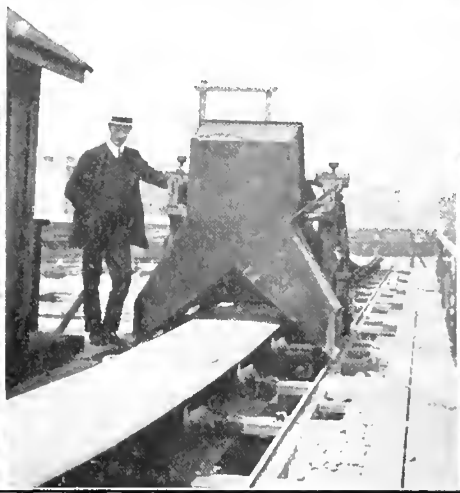
QUEBEC STREAMS COMMISSION.

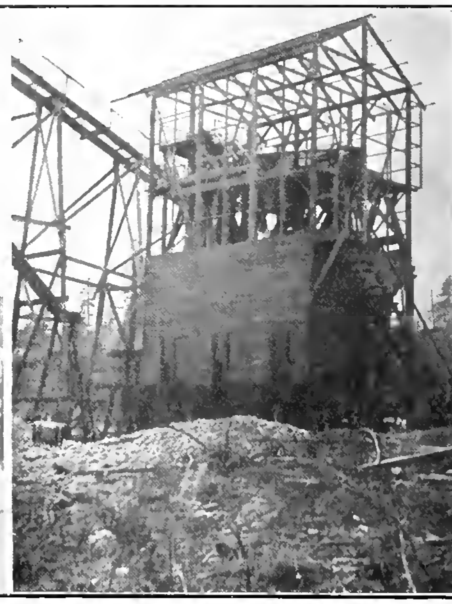
The Honorable S. N. Parent, chairman of the Quebec Water Works Commission, which has recently had its name changed to the Quebec Streams Commission and has been invested with the powers of a corporation in order to carry out its scheme of constructing a large storage reservoir on the upper St. Maurice, for the purpose of regulating the flow of that river for generating electricity, is in Quebec in connection with this work. The area of the proposed reservoir will be more than 300 square miles and the amount of water to be stored will be about 160 billion cubic feet. It will drain a basin of more than sixteen thousand square miles in area, and give a regular flow of 18,000 cubic feet per second in Shawinigan and other places.

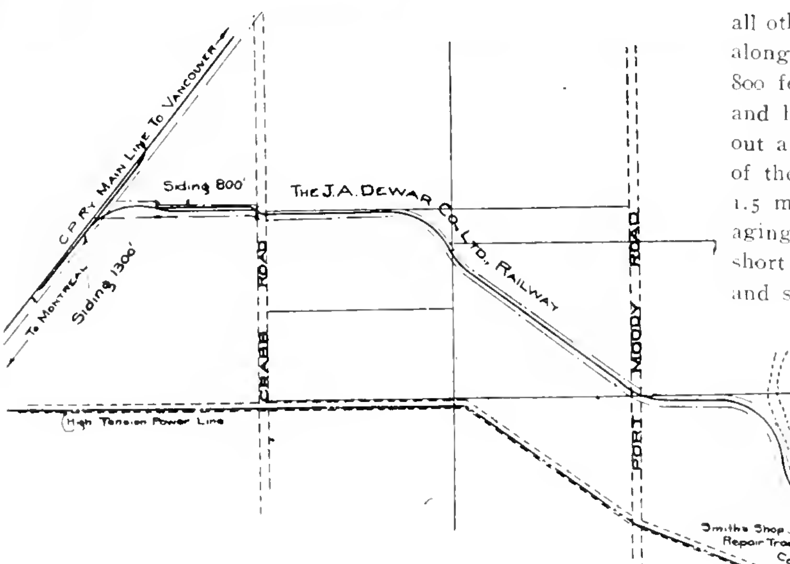
A GRAVEL SCREENING AND WASHING PLANT.

A gravel screening and washing plant built about a year and a half ago for the J. A. Dewar Company, Limited, in Vancouver, is of considerable interest from the standpoint of economical layout. The pits are located near Coquitlam, seventeen miles east of Vancouver, and the distributing plant is on False Creek in the city of Vancouver.


Rock Bin, Westminster Junction, B.C.


Tripper for Distribution to Bins.


Cravel Bin, Westminster Junction, B.C.



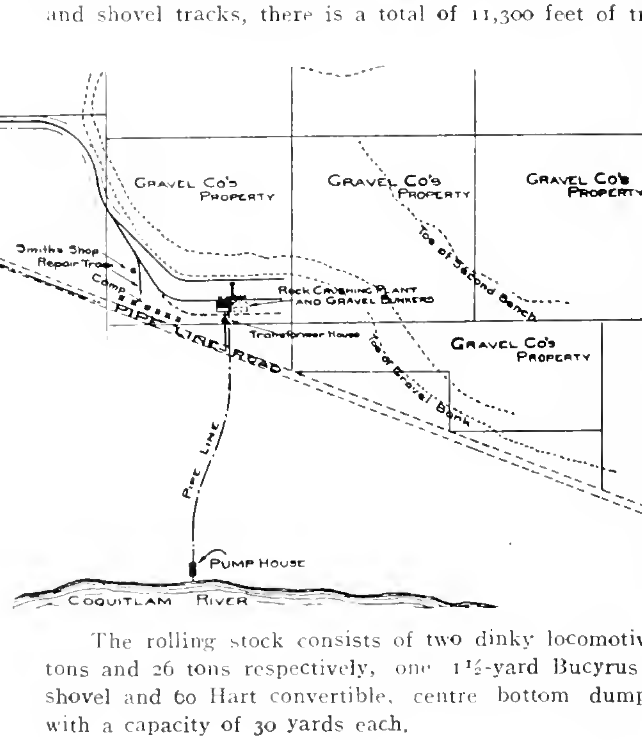


Fig. 1.—Plan of Railroad, Gravel Pit, and Pipe Line of the Gravel Screening and Washing Plant, J. A. Dewar Company, Coquitlam.

In the design and arrangement, the local demands received special consideration and although many gravel dealers brought the pit run to the machines at the city bunkers to be treated, it was decided that the place to treat the gravel was at the pit The correctness of this decision has since proved itself

The pit contains some 20 per cent. of stone too large for classification as gravel. It was therefore necessary to devise some means of disposing of it at slight cost or to put in an auxiliary rock crushing plant, and as of late the demand for crushed stone has been in advance of the supply it was decided to crush the big stones.

Fig. 1 shows a plan of the railroad, gravel pit and pipe line from the river. Fig. 2 shows on a larger scale the general arrangement of the washing and crushing plants and their relation to the pit and dumping hopper, also the system of extension. Fig. 3 shows the plant in the city.

The railway gives shipping facilities to Vancouver and all other points. The spur to the pit is connected to a siding along the main railway line of 1,300 feet, also to a siding of 800 feet along the gravel company's line, so that empties and loaded cars may be easily changed and switched without any interference with the railway company. The length of the gravel company's line from the railway to the pit is 1.5 miles and is on their own right-of-way. the grade averaging 1.7 per cent., the maximum being 2 per cent. for a short distance at one place. With the loading, repairing and shovel tracks, there is a total of 11,300 feet of track.

The rolling stock consists of two dinky locomotives, 13 tons and 26 tons respectively, one 1½-yard Bucyrus steam shovel and 60 Hart convertible, centre bottom dump cars with a capacity of 30 yards each.

Owing to the difficulty of obtaining right-of-way on certain property, the line is somewhat sinuous but it is practically a surface line and was constructed cheaply.

The pit consists of a bank some 40 feet high above the

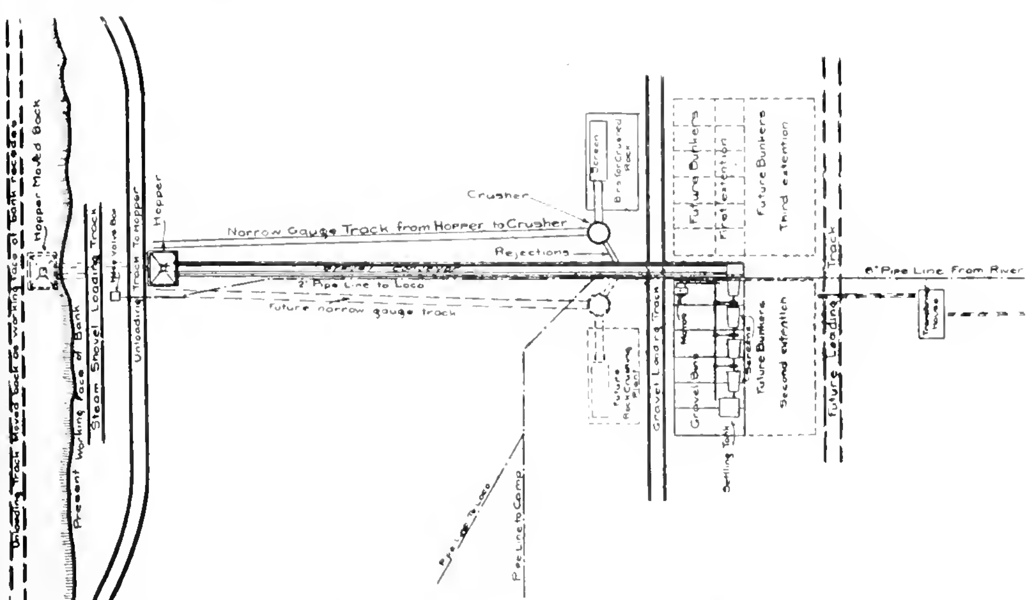


Fig. 2.—General Arrangement of the Gravel Washing and Screening Plant.

general level which gives an ideal steam shovel working face, the deposit extending over some 160 acres.

The method of operation is obvious from the layout. The steam shovel loads a 6-yard side dump car which is

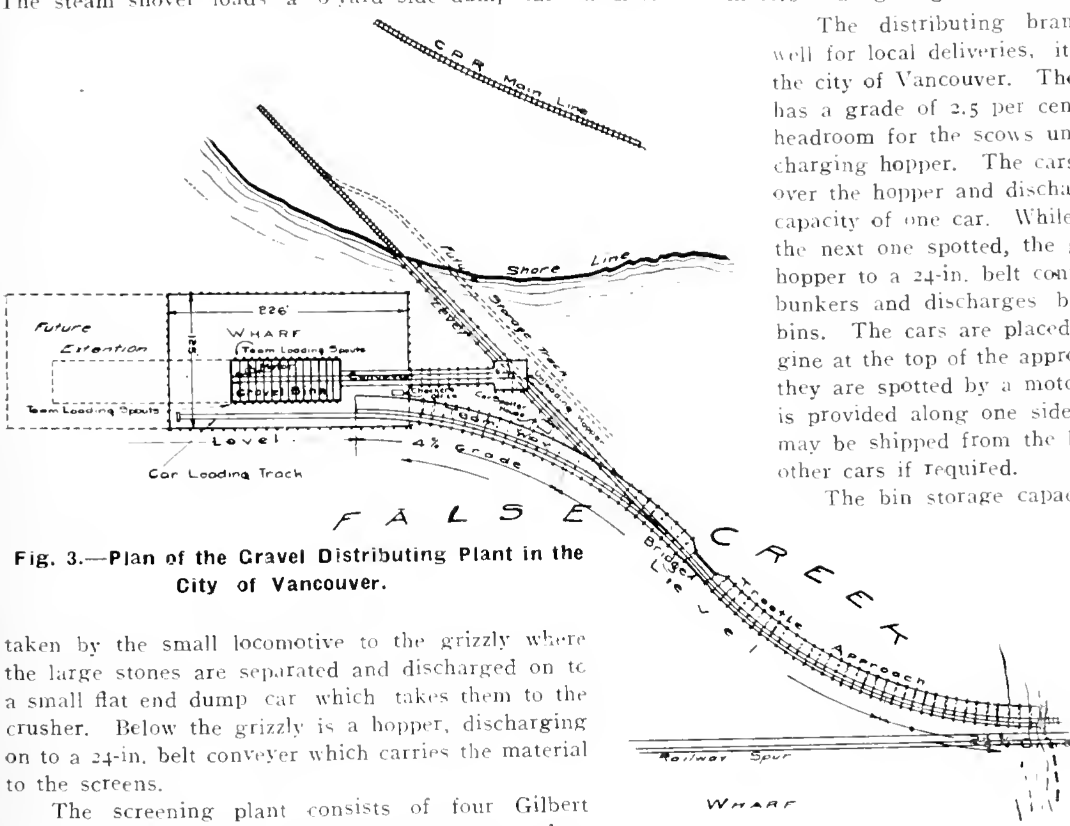


Fig. 3.—Plan of the Gravel Distributing Plant in the City of Vancouver.

taken by the small locomotive to the grizzly where the large stones are separated and discharged on to a small flat end dump car which takes them to the crusher. Below the grizzly is a hopper, discharging on to a 24-in. belt conveyer which carries the material to the screens.

The screening plant consists of four Gilbert screens, 36 in. x 54 in. x 6 ft. 0 in. (driven by a 15 h.p. motor), giving four separations 2 in., 1 in., ½ in., and sand. The sand passes through a gravity setting tank to remove the water. The rejections from the first screen pass by chute to the crusher. After being crushed they are elevated by a chain bucket elevator to the revolving rock screen which separates into three sizes, the rejections being passed back to the crusher for re-crushing.

The bunkers are arranged to discharge into the cars on the loading track alongside, the cars being pushed in by the larger loop.

As will be seen from the plan, extensions may be made to any desired capacity and the machinery duplicated without alteration or interference with the present layout. The capacity is 500 yards of gravel and 200 yards of crushed rock per 10-hour day. On the plan is shown the order of extension up to 2,000 yards of gravel and 400 yards of crushed rock.

The water used by the plant for the boilers, camp, etc., is supplied by a three stage, 4-in. centrifugal pump, located in the pump house at the Coquitlam River, a distance of 3,300 feet, and is driven by a 35-h.p. motor. The wiring is arranged so that the motor must be started from the pump-house, but may be shut down from the camp if necessary. The pipe line is a 6-in. wood pipe. Power is supplied by the B.C.E. Railway Company, at 2,200 volts, to the transformer house, where it is stepped down and fed through the switchboard to the several motors and lighting circuit at 220 volts.

The distributing branch is located exceptionally well for local deliveries, it being right in the heart of the city of Vancouver. The trestle, as shown in Fig. 3, has a grade of 2.5 per cent. on the approach to obtain headroom for the scows underneath bridge and for discharging hopper. The cars of graded gravel are placed over the hopper and discharged, the hopper having the capacity of one car. While the car is being moved and the next one spotted, the gravel has passed out of the hopper to a 24-in. belt conveyer which conveys it to the bunkers and discharges by tripper into the respective bins. The cars are placed by the C.P.R. switching engine at the top of the approach trestle, from which point they are spotted by a motor-driven car haul. Trackage is provided along one side of the bins so that gravel may be shipped from the bunkers by street railway or other cars if required.

The bin storage capacity is 1,200 yards and is arranged for team delivery. Here, again, the capacity may be increased without much alteration to the present layout, the only change being an extension to the belt conveyer and moving the conveyer head drive as bunkers extend.

Although in two branches the plant easily competes with the scow delivery usual in Vancouver, it being greatly favored by the non-liability of being held up by fogs or storms. An interesting feature at both branches of the plant is the crib type of construction for the bins, which, though not reducing the B.M. of lumber in the structure, yet allows a cheaper class of labor to be employed and requires less time for construction.

This gravel plant has been in operation 1½ years and is giving every satisfaction, both commercially and mechanically. Eighteen men are employed, including superintendent, at the pit, and two men, including checker, for the teaming at the city branch. The unloading at the city end is stated to be the most efficient and economical in Vancouver.

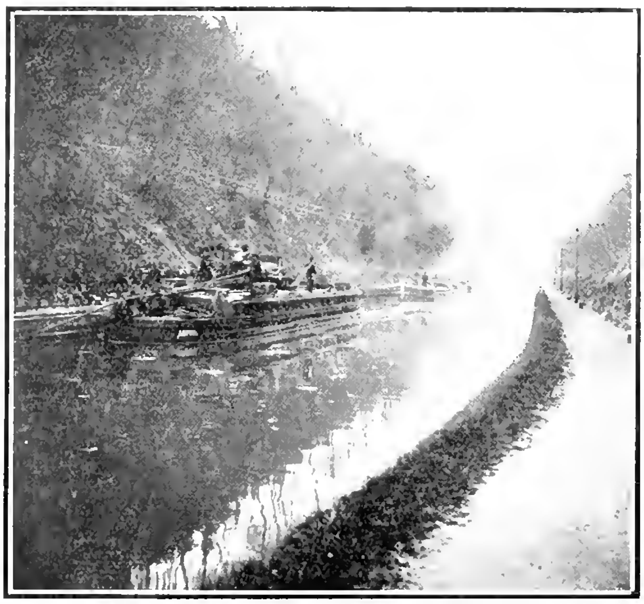
The gravel company own their own rolling stock as mentioned, also telephone system and camp. They erected the Westminster Junction plant by day labor but built the Vancouver branch by contract.

The owners are The J. A. Dewar Company, Limited, of 429 Pender Street, Vancouver. Mr. S. A. Lake, of Wilson & Lake, consulting engineers, 422 Pacific Building, Vancouver, designed and superintended the erection of the plant.

ELECTRIC PROPULSION OF FREIGHT BOATS.

It has been stated in the press that a navigation company of Montreal is considering the propulsion of boats on the Lakes. One electric motor boat, it is said, was already designed and will be operated on the same principle as an electric car.

This mode of propulsion is already used in France, and boats have been fitted out for such purpose by the "Société



View of Canal of St. Quentin, Showing Freight Boat with Electrical Propulsion.

Alsacienne"; this company is represented here by the "Engineering Works of Canada," of Montreal.

The reproduced photograph shows such an electric motor boat hauling five loaded freight boats through the canal of St. Quentin.

There was also another system tried which consisted in a motor car running along the canal and hauling the boats by means of ropes. The car was equipped with electric motors which received their power from a trolley; however, it has been found much more advantageous from every point of view to use a special boat equipped with electric motors which are mounted on the propeller shaft; the motive power is supplied from a trolley line.

This system is, of course, not applicable in the present case, but in special instances, like for ferry boats, etc., it could be used with advantage.

WHAT HYPOCHLORITE ACCOMPLISHES.

In a paper delivered before the International Congress of Applied Chemistry, held in New York City in September, 1912, Mr. C. A. Jennings gives some information regarding the true place of hypochlorite in the treatment of water. An abstract of the paper follows:—

In considering typhoid fever statistics before and after the introduction of the hypochlorite treatment, it is often very difficult to make a fair comparison, for the reason that there is a woeful laxity in reporting these statistics in many cities. This is usually conscientiously looked after following an epidemic, but seldom previous to one. However, the writer has gathered sufficient reliable bacteriological data, as well as typhoid fever statistics, to show the effect that sterilization has had on the bacterial content of the water and on the reduction in the number of cases and deaths from typhoid fever.

Bacteriological Data.

Terre Haute, Ind., has a pressure-filter plant. The average bacterial count for February, March and April, 1912, was: Raw water, 3,870 per c.c., with B. coli present in 68 per cent. of the samples tested, while the filtered and sterilized water showed only 34 per c.c., with B. coli absent in every sample tested. Samples were collected daily.

Cedar Rapids, Iowa, began using hypochlorite in March, 1912, as an adjunct to its rapid sand filters, and the results have been spectacular. During the period from March 29 to May 15, 1912, the raw water averaged 40,200 bacteria per c.c.; filtration alone showed a reduction in bacteria of 1,700 per c.c., or 95.8 per cent., while the hypochlorite treated water count was only 44 per c.c., or a total reduction of 99.9 per cent. B. coli was present in 63 per cent. of the raw water samples examined, in 36% of the filtered water samples, but not a single 1 c.c. portion of the sterilized water showed B. coli.

Montreal, Que., draws its water supply from the St. Lawrence River, and sterilizes it with hypochlorite. The untreated water averages 800 bacteria per c.c., with B. coli present in 98 per cent. of the 10-c.c. portions, and in 45 per cent. of the 1-c.c. portions tested. The treated water averages 25 bacteria per c.c., with B. coli absent in both 10-c.c. and 1-c.c. portions tested.

Grant's Pass, Ore., has, as its source of supply, Rogue River, a clear mountain stream. However, there are several sources of pollution by sewage from cities above. The hypochlorite treatment reduces the bacteria from an average of 600 to 15 per c.c. Since the hypochlorite process was begun September 16, 1911, and up to June 1, 1912, there were but two cases and no deaths from typhoid fever reported in this city of 5,000 inhabitants.

Baudette, Minn., had a typhoid fever epidemic in the fall of 1910, and began immediately to sterilize the water supply. No specific data are available, but the following quotation from a letter from the town clerk is significant: "It has been our experience that the hypochlorite plant is a very valuable asset. Previous to installing the hypochlorite plant typhoid fever was very common. Since that time (to May 30, 1912) no typhoid fever has been called to our attention. We, therefore, believe that the hypochlorite plant has been a very satisfactory preventive of this class of disease."

Nashville, Tenn., after drawing the water from the Cumberland River, coagulates it with alum and allows it to settle in large basins. It is then sterilized with hypochlorite of lime. The average bacterial content of the raw water is 3,000 per c.c., with 90 per cent. of the 1-c.c. portions tested showing B. coli present. The settled and sterilized water shows an average of only 70 bacteria per c.c., and during the year 1910 only three samples out of 1,200 tested showed B. coli present.

Danville, Ill.—Although Danville has been using the hypochlorite treatment as an adjunct to its rapid sand-filter plant for only a very short time (since February, 1912), nevertheless the bacterial data on the filtered water are very interesting. During the time that hypochlorite was used the average bacterial content of the sterilized filtered water was only 57 per c.c. During the period from March 20-25, inclusive, the supply of hypochlorite was exhausted and so none was used. The bacterial content of the untreated filtered water during this period was 4100 per c.c. With hypochlorite treatment in use Mar. 19, the count was but 20 per c.c.; on Mar. 20, without hypochlorite, the count jumped up to 8400 per c.c. The removal by filtration without hypochlorite, from the raw water averaging 67,000 bacteria per c.c., was 93.9%; by filtration and hypochlorite from the raw water averaging 52,406 bacteria per c.c., the removal was 99.89%. Without sterilization, B. coli was present in the filtered water on five of the six days; with sterilization, B. coli was present on one day out of 34. The turbidity of the raw water was so low from May 26 to June 1, 1912, that no coagulant was used and only hypochlorite added to the filtered water. The average reduction in bacteria during this period was 99.6%.

Typhoid Statistics.—A comparison of typhoid-fever statistics before and after the introduction of hypochlorite is very interesting.

North Yakima, Wash.—In 1910 there was a typhoid epidemic caused by a contamination of the domestic supply through a cross-connection with a highly-polluted fire service. During the period September, 1911, to June, 1912, there was not a single death from typhoid fever and only one case was reported between Dec. 22, 1911, and June, 1, 1912. The water sterilization began July 9, 1911. The source of supply is a mountain stream which is open to contamination. The reduction in the number of cases and deaths from typhoid fever is due in part to the general clean-up and condemnation of many polluted shallow wells as well as to the hypochlorite treatment in this booming city of the Northwest.

Council Bluffs, Iowa.—The wonderful efficiency of hypochlorite is shown by a typhoid-fever epidemic in Council Bluffs, Iowa, which began in the fall of 1909 and ended with the introduction of hypochlorite in April, 1910. Since this treatment was inaugurated, a period of 25 months to June 1, 1912, there have been but five deaths from typhoid fever in this city with a population of 30,000 and one of these five deaths was that of an imported case. This is a remarkable record. For the eight months following the introduction of hypochlorite there was not a single death from typhoid fever.

Cleveland, Ohio., draws its water-supply from Lake Erie, which is polluted in part by its own sewage and in part by neighboring cities. After typhoid fever had been prevalent to a great degree in this city for years a remarkable reduction in the number of cases and deaths from this disease followed the beginning of the treatment with hypochlorite in September, 1911. There was 159 cases and 19 deaths reported for that month. For the eight months, Oct. 1, 1911, to June 1, 1912, there were totals of 180 cases and 28 deaths reported. During similar periods in previous years the figures are:

	Cases.	Deaths
Oct. 1, 1907 to June 1, 1908	290	46
Oct. 1, 1908 to June 1, 1909	311	52
Oct. 1, 1909 to June 1, 1910	343	66
Oct. 1, 1910 to June 1, 1911	347	65
Average 1907-1911	323	57

These figures compared with 180 and 28 cases and deaths, respectively, for 1911 to 1912 show reductions of 44% in the number of cases and 50.8% in the number of deaths. This represents an average of 29 fewer deaths in eight months, while hypochlorite was being used compared with the period before the water was treated. Taking the figure of $5,000 as the value of each life sacrificed to typhoid fever, the financial saving effected by hypochlorite in eight months has been $145,000, which amount capitalized at 5% represents the tremendous sum of $2,900,000.

Erie, Penn.—Although it is acknowledged that the typhoid epidemic at Erie was water borne, nevertheless the exact point of introduction of the contamination has not been definitely determined. The water-supply is taken from Lake Erie and, previous to Mar. 15, 1911, was not treated with hypochlorite. December, 1910, with 31 cases and 2 deaths was followed by January, 1911, with 239 cases and 24 deaths. The Pennsylvania State Board of Health began treating the water-supply with copper sulphate Jan. 28, 1911, and this was continued until the hypochlorite was substituted. The latter process has been in use without cessation since Mar. 15, 1911. The number of cases and deaths from typhoid fever during the twelve months from June 1 to May 31, during the past four years, is as follows:

	Cases.	Deaths.
1908-1909	153	16
1909-1910	202	29
1910-1911	1140	136
1911-1912	91	11

Thus it will be seen what a good record the hypochlorite treatment has made at Erie in the reduction of typhoid fever. The average number of cases and deaths for the three years 1908-1911 was 498 and 60 compared with 91 cases and 11 deaths since hypochlorite has been used. The value of 49 lives saved from typhoid fever at $5,000 each is $245,000, which, capitalized at 5%, amounts to a total of $4,900,000. The raw water averaged 674 bacteria per c.c., with B. coli present in 11% of the samples tested, while the treated water averaged only 49 bacteria per c.c., with B. coli present in only 1 sample out of 1,025 examined—less than 0.1%.

Toronto, Ont.—During the first two months of 1910 there were 723% more cases and 450% more deaths from typhoid than the average for the same two months during the five years previous. Hypochlorite treatment was begun in March, 1910, and an immediate reduction in the number of cases and deaths was effected. The cause for a rise of cases to 90 for two consecutive months in 1911 is explained in a quotation from a letter from Dr. Geo. C. Nasmith, Director of Municipal Laboratories:

I may say that last year our intake plugged with sand and we were forced to short circuit our water-supply and take it from the Bay into which all our sewage empties. We had the makings of the largest typhoid epidemic ever known on this continent, but fortunately we had hypochlorite to depend on and we came through with a typhoid death rate of 20 per 100,000 in 1911, as compared with 45 per 100,000 in 1910, which, you will agree, was an extremely satisfactory showing.

The first four months of 1912 show 64% fewer cases reported than the same period in 1911 and 65% fewer cases than the average for the same periods 1905 to 1910 inclusive and 50% fewer deaths.

Baltimore, Md., drawing its water-supply from two impounding reservoirs, began to sterilize the water with hypochlorite on June 6, 1911, to keep down the annual autumn typhoid-fever epidemic. Since then both cases and deaths have been lower than before the use of hypochlorite. For the period June 1, 1910, to May 31, 1911, there were 1,964 cases and 233 deaths from typhoid fever, while from June 1,

1911, to May 31, 1912, while using hypochlorite, there were 1,155 cases and 160 deaths, reductions of 41% and 31%, respectively. Hypochlorite treatment presumably saved 73 lives in one year. These valued at $5,000 each, amount to $365,000, which totals the enormous sum of $7,300,000 when capitalized at 5%. This is a wonderful saving to a community of 564,000 people in twelve months.

Evanston, Ill.—During the past winter Evanston, Ill., had a typhoid epidemic, traceable to the water-supply, contaminated by the sewage of the city itself. Although the use of hypochlorite was not begun until December 10, 1911, nevertheless there was a reduction from 40 cases reported in December, 1911, to 12 cases in January, 1912, which dropped still further to nine cases in February, showing how thoroughly the hypochlorite treatment did its work. The untreated lake water, averaging 5,000 bacteria per c.c., with B. coli present, was reduced to an average of 75 per c.c., with B. coli shown to be present in all 1-c.c. portions tested.

Waukegan, Ill.—Conditions as to the pollution of the water-supply of this city with the city's own sewage are identical with those of Evanston. The increase in typhoid-fever cases reported, however, occurred later than in Evanston. A total of 82 cases in March was reduced to 50 in April and 27 in May, hypochlorite having been used for the first time on April 16, 1912.

Minneapolis, Minn.—There was an abnormal amount of typhoid fever in 1909 and 1910. The water-supply was taken from the Mississippi River without any treatment. The use of hypochlorite was begun late in 1910 and has been continued without interruption since that time. A modern filter plant of the rapid sand type is now being constructed, but the hypochlorite process will be used in conjunction with it when completed. The water is reduced from an average of 816 bacteria per c.c. to 5 per c.c. The 39 typhoid deaths in the ten months before hypochlorite and the two deaths in the ten months after hypochlorite was used, or a reduction of 95%, is remarkable.

Omaha, Neb.—Hypochlorite has been used since May, 1910, at which time there was an epidemic of typhoid in the city. The Omaha typhoid fever death rates per 100,000 for the last four years have been:

1908	1909	1910	1911
16	26	67	13

A reduction from 67 to 13 per 100,000 is remarkable and it is difficult to say how much higher the rate would have been in 1910 had not the sterilizing process been installed in May of that year. It is worthy of mention that the treated and settled water shows an average of only 43 bacteria per c.c., whereas the raw water from the Missouri River averages 30,447 per c.c.

Jersey City, N.J., was one of the first cities to adopt hypochlorite treatment for municipal water-supplies. The water from the storage reservoir averages 12,000 bacteria per c.c., with B. coli present, but the treated water averages only 10 per c.c., with B. coli absent. Hypochlorite treatment was begun in September, 1908. The average for 1905, 1906 and 1907 was 18.5 per 100,000, and this was reduced to an average of 9.6 per 100,000 for the three years following the use of hypochlorite, namely, 1909, 1910 and 1911, a reduction of 48% in the average typhoid fever death rate.

Kansas City, Mo., takes its water-supply from the muddy and polluted Missouri River and by means of sedimentation and sterilization reduces the bacterial content from an average of 5,500 per c.c. to 65 per c.c. The raw water shows B coli present in 0.2 c.c., whereas this sewage organism is absent in all 1-c.c. portions of the treated water tested. The number of typhoid deaths reported during 1910 without sterilization of the water was 107, while for 1911, with hypochlorite treatment in use, it was 61, a reduction of 43%. Many people in Kansas City use the clear and sparkling waters that issue in many places from springs and which can be pumped from surface wells. These waters have been shown to be very highly contaminated, although they are of very attractive appearance. The city is now conducting a campaign to discontinue the use of these waters for drinking.

Cincinnati, Ohio., has a rapid sand-filter plant with a capacity of 112,000,000 gal. per day. The hypochlorite treatment has been used as an adjunct to the filtration process since December, 1910, with a reduction from an average of 315 to 26 per c.c., or 91.7% reduction in the filtered water itself. B. coli was present in 0.6% of the 1-c.c. samples and in 91.1% of the 100-c.c. samples of filtered water examined, but in the treated filtered water tested no 1-c.c. portions showed B. coli present and only 12% of the 100-c.c. portions were positive.

These data show conclusively that the hypochlorite of lime treatment of water-supplies is wonderfully effective; that it reduces the bacterial content of water to a very low number; that it practically eliminates B. coli and, therefore, we think, B. typhosus, from water-supplies; that it is a very valuable adjunct to filter plants; that mountain streams and impounded reservoir supplies are made safe by its use; that it has stopped many typhoid-fever epidemics already begun and in all probability it has prevented many epidemics from occurring. Hypochlorite is not a panacea for all troubles arising from water-supplies, but when properly applied to the proper water in the correct quantities, it will accomplish wonderful results. Its great cheapness as to installation and operation, the short time necessary to install the treatment and its comparative simplicity, will surely cause disinfection by hypochlorite of lime to be continued and to be adopted by other cities where the supply is not all that it should be.

NEW HARBOR COMMISSIONERS.

Messrs. W. G. Ross, F. Robertson and Lieutenant-Colonel A. E. Labelle are the new harbor commissioners for Montreal.

Mr. Ross is a prominent business man and is a Montrealer by birth. His business career has been a bright one, and as managing director of the Montreal Street Railway from 1905 to 1911, he did much to make that one of the strongest of Canadian corporations. At the present, Mr. Ross holds the following offices: President of the Asbestos Corporation of Canada, director in the Dominion Steel Corporation, in the Quebec Railway, Montreal Light, Heat and Power Company; also many other official connections with noted Canadian corporations.

Mr. Farquhar Robertson, coal merchant, hails from Glengarry county, Ontario, having devoted several years of his life to farming in that district. His first step into commercialism was made when he became manager of a Montreal lumber concern. He started his coal business in 1879. Mr. Robertson is a director of the Montreal Transportation Company, the Prudential Trust Company, and was president of the Montreal Board of Trade in 1909, having been vice-president the year before. He is prominently identified with charitable undertakings, and was three times elected by acclamation to represent St. Andrew's ward in the city council.

Lieutenant-Colonel Alfred E. Labelle was born in Montreal, and has been for more than a quarter of a century one of Canada's most prominent grain merchants. In company with Sir Rodolphe Forget, George A. Grier and Thomas Williamson, he organized the St. Lawrence Flour Mills Company, of which he was chosen managing director. He is the president of the Chambre de Commerce and is prominently identified with the Canadian militia.

THE IMPROVEMENT OF VANCOUVER HARBOR.

In an article published in a recent issue of the British Columbia Magazine, Mr. R. H. Parkinson outlines certain improvements for the improvement of Vancouver Harbor by a suggested sea wall across the Second Narrows. As the matter is of considerable interest on account of the rapid approach of the completion of the Panama Canal we herewith present the discussion.

Canada's western portal "the lion's gate" gives entry to Vancouver Harbor, a salt water basin bounded on the west and east respectively by the First and Second Narrows of Burrard Inlet. This arm of the sea continues some sixteen miles inland in an easterly and northerly direction beyond the Second Narrows.

The whole area of Burrard Inlet is approximately 14,000 acres, while the area of Vancouver Harbor, lying between the First and Second Narrows, is about 3,200 acres.

The purpose of this paper is to point out some of the defects of this harbor, and to suggest a means of eliminating them, and of so improving the conditions as to make Vancouver one of the finest seaports in the world.

The shore line or possible length of wharf (parallel thereto) in this harbor exceeds eleven miles; but, owing to existing conditions, only a small proportion of shore line is used for wharves.

The existing wharves are built on piles, which are very short-lived, owing to the action of the teredo navalis, which honeycombs them and makes re-piling a constant necessity and expense.

The greatest disadvantage of the harbor is, however, its difficulty of entry through the First Narrows. This channel, which has a width of 780 feet, and a depth in mid-channel of 12 fathoms, has a cross-sectional area of 30,500 square feet, through which, at spring tides, the water rushes at the rate of six to eight knots an hour, causing back eddies and whirlpools, which are very dangerous to small crafts and even to large steamers during the period of foggy weather which prevails in winter. The tidal conditions are, indeed, so adverse as to cause serious menace and delay to shipping, and the accidents, collisions and wrecks that have occurred in these Narrows must be attributed to the high velocity of the tides and the cross currents caused thereby.

This high speed of the tide is also found in a lesser degree along the north shore of the harbor, where the city of North Vancouver is situated, and detracts from its value as a location for wharves at a point where the need of them is becoming more and more apparent.

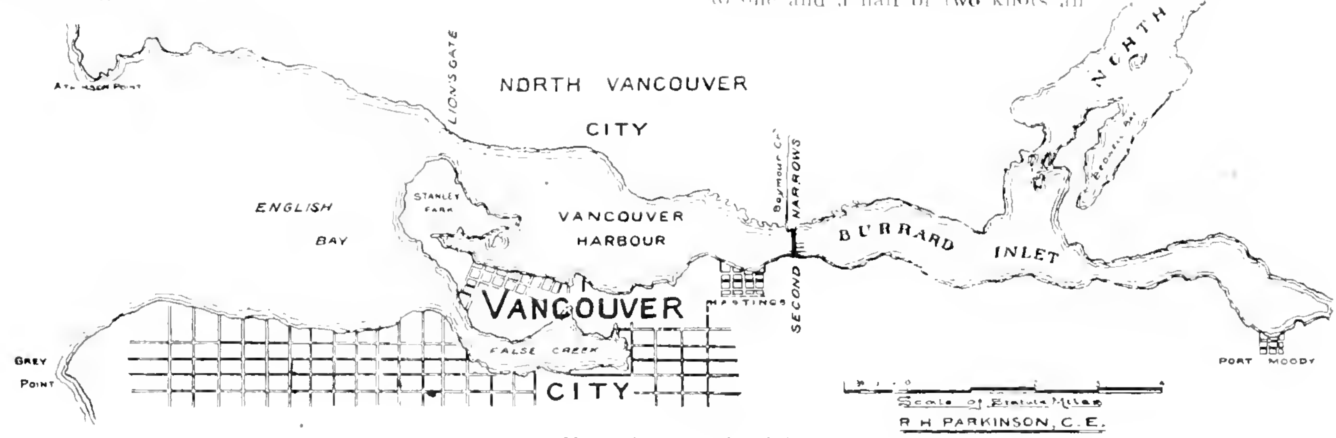
Another disadvantage at present existing is the lack of anything but steamer communication between Vancouver and her sister city across the harbor.

The difference of level between high and low tides is about fifteen feet, and this is a serious inconvenience, causing increased expense in the loading and unloading of ships. In older countries dependent largely on their sea traffic, vast systems of wet docks have been constructed to overcome the disadvantage of excessive tidal rise. The Thames has a tidal rise of 20 feet, and to contend with this London has built over 400 acres of wet docks.

Liverpool, with a tidal rise of from 20 to 30 feet, has the finest dock system in the world, consisting of over 600 acres of wet basins, with over 40 miles, of dock space. Part of these docks have cost as high as $244,000 an acre. It is therefore evident that a large tidal rise is considered such a detriment to a port as to warrant the expenditure of enormous sums of money in improving the harbor facilities.

The remedy for the evils mentioned, in the belief of the writer, lies in the erection of a sea-wall across the Second Narrows, which might take the form shown in the annexed plan and elevation.

The effect of such a construction would be, first, to reduce the velocity of the tide entering the lion's gate from about seven knots to one and a half or two knots an hour; that is, to reduce the current to one-third of its present velocity, thus making the harbor free of entry without danger even to the smallest craft at any stage of the tide.



Map of Burrard Inlet.

This would have the effect of changing the Inlet above the Second Narrows from an arm of the sea into a vast wet basin of fresh water, since the many streams flowing into the Inlet would not only drive out the salt water from above the Second Narrows, but would most likely have the effect of freshening the then limited area of water in Vancouver Harbor to such an extent as to entirely check the ravages of the teredo navalis.

The suggested sea-wall would be provided with locks of sufficient capacity to accommodate the largest ships. It would be provided with graving docks, with subways for electric power lines and aqueducts. On the surface would be tramways, and a railway for the common use of railroads entering Vancouver, obviating the necessity for the intended railroad cantilever bridge across the Narrows, and would very likely render unnecessary the projected improvements to the channel of the lion's gate. Moreover, by giving ships access to fresh water it would make it possible to clear them of barnacles and other impediments in the cheapest manner.

By the aid of this sea-wall the water above could be maintained at or about the present level of high water, and would consequently simplify the matter of stevedoring and wharf-building throughout the upper arm of Burrard Inlet.

This highwater level would also render the upper arm navigable to the largest ships, and would in time undoubtedly have the effect of promoting manufacturing enterprises on lands free from the taxes of a large city and yet within reach, by tram or train, of the working classes residing there.

The people and the factories cannot exist together in perfect conditions of health. In every large town the factories are crowding the residences further and further into the suburbs, and Vancouver must now decide whether she will gradually give up her unrivalled and beautiful situation to the demands of commerce or whether she will provide for a vaster commerce and a healthful people, by encouraging the establishment of industries without her gates and yet within reach of her workers.

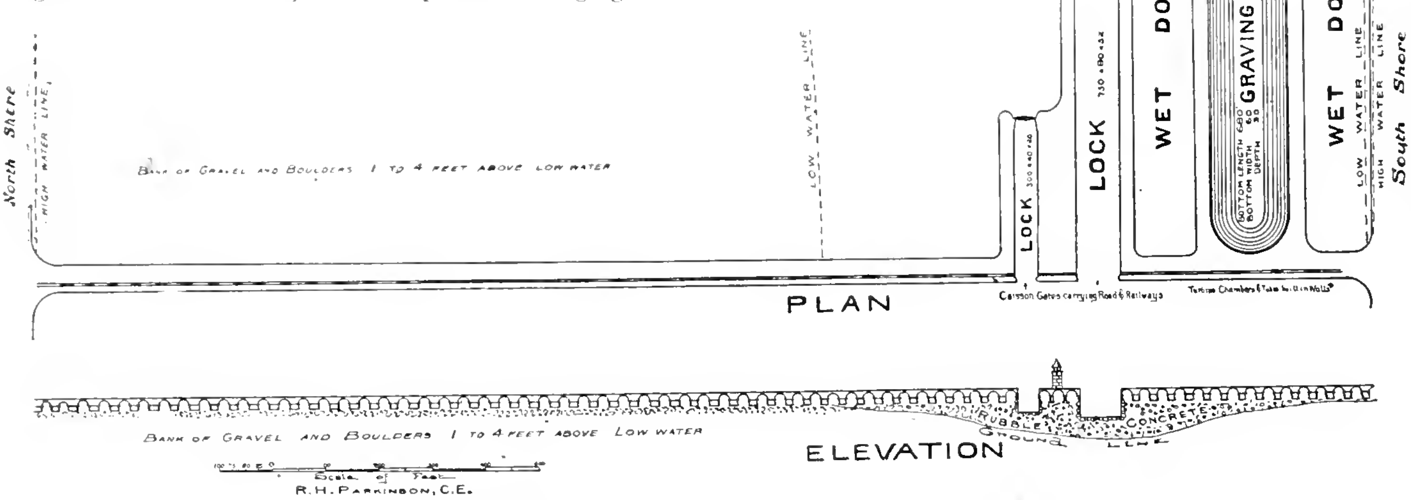
Vancouver rejoices in the mildest winter of any port in Canada. Burrard Inlet is free from ice at all times. The water is clear and free from silt, and the streams flowing into it are mostly of the nature of mountain cataracts, which descend through rocky canyons and carry very little wash with them. The sea-wall and docks suggested would therefore have very little silt to contend with.

The south shore of the Second Narrows is bedrock, which probably extends the greater part of the distance across. If this is the case, then the cost of the proposed works will be far less than the cost of works of the same magnitude built elsewhere, for the expense of dredging will not be encountered, except in the gravel bank on the north shore, and this is dry at low water. To find the cost of the proposed works will therefore be largely a calculation of the cost of so many cubic yards of reinforced concrete, to be laid under rather difficult conditions; together with the cost of the necessary caisson gates for the locks and bridges for the railways and highway. The main wall and dock walls shown on the plan are from 30 to 50 feet wide on the surface; these widths are, of course, excessive as far as strength is concerned, and they may be constructed of parallel walls of ten feet in thickness, filled in with boulders or joined at the tops by arches or girders to form the floor of the quay. It would be advisable to build in the walls tubes of over six feet in diameter, which could be used for such purposes as aqueducts and conveyers of electric high-voltage wires. Cross tubes would be provided in the main wall for spillway and also chambers about low-water level for turbines, the water supply for which could be taken in at the foot of the pier ends and thence through tubes laid in the dock walls to the turbine chambers.

The filling and emptying conduits of the docks and dry docks would require to be of large aggregate area, so that when all these voids in the walls are accounted for the volume of concrete used in construction would not exceed one-third of the gross bulk of the walls and piers shown on the plan, and this volume could be reduced by filling in the walls with boulders, of which there is a plentiful supply along the north shore.

Roughly the gross volume of rubble and reinforced concrete required for the works shown would be about 400,000 cubic yards, the average cost of which should not exceed $6 a cubic yard. Therefore, with caissons, tracks, turbines and other equipment the total cost of the proposed works should not greatly exceed two and a half million dollars.

When it is considered that the Esquimalt dry dock (475 feet long, built of masonry) cost three million dollars, one can realize the great advantage which the site of the proposed dry dock possesses, as it is designed to be built at a point where the rock bed of the Inlet lies at just a sufficient depth (35 feet) below high water, which would be the permanent level of the upper inlet, thus requiring only the retaining walls and altars to be built of concrete at a cost less than that of the Port Orchard, California, dry dock (675 feet long), which is built of timber, faced with concrete, at a cost of $600,000, and is at present the largest dry dock on the Pacific Coast.



Suggested Sea-Wall at Second Narrows, Vancouver Harbor.

The writer has at present nothing but an Admiralty chart and his own observation (during a three years' residence in Vancouver) of the existing conditions to guide him in this design, and it would be necessary, of course, to make a careful survey of the site of the proposed sea-wall in order to prove the nature of the channel-bed and the exact dimensions of the channel, before a proper design could be prepared or an accurate estimate of the cost determined.

The proposed works might well be located at the First Narrows, were it not for the delay which would be caused to the passenger traffic.

As an investment of capital the proposed works should pay well, since the tram and railway tolls and harbor dues should amount in the course of a few years to enough to pay a good percentage on the investment.

But the competition of the United States ports to the south makes it important that Vancouver Harbor should be made attractive to shipping, and even if the works were toll free and dues free, the enormous impetus they would give to Canadian ocean traffic and to manufacturing enterprises would be a vast gain to the Dominion, not to be measured merely in dollars and cents, but in commerce and population—in enterprise and prosperity.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc. MANAGING EDITOR | A. E. JENNINGS, ADVERTISING MANAGER | P. G. CHERRY, B.A.Sc. CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (7s.)	$1 00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JANUARY 9, 1913. No. 2

CONTENTS OF THIS ISSUE.

TORONTO'S WATER SUPPLY: FROM SCARBORO OR CENTRE ISLAND?

The editorial on Toronto's Water By-law, which appeared in these columns in the issue of December 26th, has been productive of criticism on the part of Mr. Isham Randolph and Mr. Willis Chipman, who are members of the Board of Water Commissioners, which Commission recommended the establishment of the duplicate water plant for Toronto at Scarboro Bluffs.

Our criticisms of their report were made from facts, and, as is obvious, were intended in no sense as a personal attack on these gentlemen. Mr. Randolph, of Chicago, however, in commenting on the editorial, through the medium of the daily press, states that: "Now, personally, *The Canadian Engineer* carries no weight with me. Its editors do not impress me as being fair-minded." His attitude is due, no doubt, to the fact that several times during the past year we have had occasion to comment unfavorably on reports and recommendations made by him on other matters. A reference to the files of *The Canadian Engineer* will make clear why Mr. Randolph does not feel that we are fair-minded. A perusal of these editorials will give the reader the opportunity of judging for himself on that question.

The following quotation, made from Mr. Randolph's criticism, exemplifies very clearly his attitude of mind (or shall we say of "I") upon which we commented, with regard to his report on the Chicago Drainage Canal: "**I** have to deal with such a variety of questions that **I** fear **I** have the habit of relieving **my** mind of the whys and wherefores that have influenced **my** conclusion upon a subject, when once that conclusion is reached and announced; so, feeling mentally freer to tackle the next question with which **I** have to deal."

In the Toronto Star of December 26th Mr. Chipman states that in the Scarboro scheme the water will only need to be pumped once, and that the cost of pumping the water twice from the Centre Island plant would be more than the extra cost occasioned by the extra lift. Evidently, Mr. Chipman had forgotten the comments made on page 14 of the Board of Commissioners' report, in which it is stated that: "West Toronto will thus be supplied from the Scarboro reservoir by gravity. For the higher districts lying north of Davenport Road and the easterly branch of the Don it will be necessary to re-pump the water required, and, as this district is rapidly increasing in population, additions to the pumping machinery will be frequently demanded."

In the Toronto Telegram of December 27th Mr. Chipman states: "We do not say that continuous filtration is absolutely necessary. There is a possibility that filtration will not be required there (at Scarboro) all the time. We believe that there are times when neither filtration nor chlorination will be necessary." Evidently, Mr. Chipman has revised his opinion since the report of the Board of Commissioners was made, for on page 13 of the report it is stated that: "It should be borne in mind that bodies of infected water are floating in the lake, and to guard against the possibility of danger from this source it is advisable that the water should at all times be filtered."

We have no desire to engage in a controversy over the relative merits of Scarboro or Centre Island as a source of supply. In our previous editorial we presented certain facts, and these facts have been questioned by members of the Commission and others. The facts demand that an unbiased and unprejudiced view of the whole matter be presented.

The statement is often repeated, both by the Commissioners and by the public, that there is a greater probability of obtaining purer water for greater lengths of time at Scarboro than at Centre Island. On page 71 of the report the Board of Commissioners state that the transporting currents depend entirely upon the wind. The results of certain experiments made in the year 1909, by City Engineer Rust, and given on page 76 of the Commissioners' report, were that "the net result of our observations is that the wind controls the current, and that during the last year the wind blew away from the present intake 68.9 per cent. of the time." Records of the Meteorological Service show that the greater proportion of winds at Toronto come from the west.

With these facts clearly in mind, it is hard to understand Mr. Chipman's statement that it will not be necessary to filter at all times at Scarboro.

It is agreed by the Commissioners that it will cost more to pump the water at Scarboro than it will at Centre Island, but they claim that this extra cost will be off-set by the fact that he Centre Island has to be pumped twice under present conditions. Yet, they expressly state that "booster" pumping stations will be required throughout the city on the feeder from Scarboro.

The serious defect in the Scarboro scheme, more serious than the question of first cost or the question of operating cost, is the defect which is common to all gravity systems; and it might well be questioned whether it would be advisable to use Scarboro as a source of supply, even if it was unnecessary to raise the water 330 feet from lake level to the elevation of Scarboro Bluffs. This defect is the fact that the elevation of the reservoir at Scarboro, with the gravity pipe line feeder, absolutely fixes the amount of energy present in the system. That is, when no water is flowing through the gravity line the pressure head will stand at the level of the reservoir. When the demand increases the head drops as the friction loss increases, until at the point of maximum water demand the minimum head is available. There is no way of controlling this variation in the pressure in a gravity system, and the result is the most undesirable condition of maximum demand and minimum pressure. On the other hand, with the present pumping system, as the demand increases, more energy is put into the system by increasing the pumping capacity, and, therefore, the pressure can be kept at almost a constant.

This fact in favor of the pumping system cannot be too strongly emphasized. It is a matter which has been entirely overlooked in the Board of Commissioners' report. To show what the result would be, it is only necessary to take an example. Mr. Chipman states in the Toronto Telegram of December 27th that with the maximum demand there will be a loss of head of about seven feet in the mile. That is, at the present high-level pumping station there will be a loss of 84 feet of head under conditions of maximum load. When there is no demand for water the pressure level will be at the elevation of the Scarboro reservoir. This will mean that the house services in that neighborhood are subjected to a daily variation in pressure of 84 feet. At West Toronto conditions will be far worse than this unless "booster" pumps are used. It would be interesting to know if the Commissioners had at all considered this variation in pressure. It would also be interesting to know how they intended to control the excess pressure in the east end where the ground level is 250 to 275 feet below the elevation of the Scarboro reservoir.

The absolute lack of flexibility of a gravity scheme such as that from Scarboro, together with its greater first cost and the greater continuous cost of operation, demands the city's consideration of a duplicate Centre Island plant.

LETTER TO THE EDITOR.

DESCRIPTIONS OF LAND.

Sir,—I send you herewith copy of description taken from deed of a lot of land in New Brunswick. This is a fair sample of hundreds of descriptions still used in that province.

The registration system is antiquated and, as there is no complete system of lot numbers, a separate index for each lot is not used in the registry offices.

This entails enormous waste of time and money in making searches against titles and uncertainty as to completeness.

It would be a decided benefit to land owners in New Brunswick if the Dominion Government would apply part of the annual subsidy to establishing a registry system similar to the Cadastral system in Quebec province.

The Provincial Government seems to be helpless in the matter.

Yours truly,

H. IRWIN, Q.L.S.

370 Kensington Avenue, Westmount, P.Q., 28th Dec., 1912.

Description.

"All that certain lot of land situate in the Parish of Douglas . . . bounded and described . . . as follows: On the south by the Saint John River, extending eastward to an oak tree near a brook, thence northerly to a hemlock tree near the highway road, thence westerly to a willow tree on the north side of the said road; thence northward to a cedar post near a brook; thence following the said brook to near the head, and so on to a spruce tree on Hallett's line, and thence following the said Hallett's line to the oak tree aforesaid on the bank of the River St. John, being the same lot of land conveyed to the said Thomas E. Wheeler by Charles J. Tozier."

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for December, 1912:

	Depth in inches.	Departure from the average of twenty years
Calgary, Alta.	...	......
Edmonton, Alta.	0.1	—0.70
Swift Current, Sask.	0.3	—0.42
Winnipeg, Man.	...	......
Port Stanley, Ont.	3.4	+0.32
Toronto, Ont.	1.85	—0.76
Parry Sound, Ont.	7.7	+3.04
Ottawa, Ont.	2.2	—0.51
Kingston, Ont.	2.4	—0.44
Montreal, Que.	2.9	—0.92
Quebec, Que.	3.0	—0.16
Chatham, N.B.	3.2	+0.02
Halifax, N.S.	8.4	+2.71
Victoria, B.C.	5.8	—0.47
Kamloops, B.C.	0.5	—0.32

REINFORCED CONCRETE ELEVATED WATER TANK AT BERLIN, ONTARIO.

Although elevated water tanks were the first important reinforced concrete structures built in Europe and although there are some railroad tanks made of this material still in existence which were built over fifty years ago, the construction of large elevated water tanks for municipal use is still something of a novelty in this country. The following description and illustrations of reinforced concrete tank recently completed at Berlin, Ontario, are taken from a recent issue of "Engineering-Contracting," to whom acknowledgement is here made:—

The capacities and heights of elevated tanks are increasing each year. With increase in size, economical design of the bottom and supports of elevated concrete tanks becomes highly important, since the cost of these parts of such structures is by far the greatest item of expense in building a tank of this character. The ordinary girder and slab construction for the bottom of large tanks is a very expensive feature in concrete tank construction. Loads of from 1,000 to 3,000 lbs. per sq. ft. require very heavy beams and slabs and a great many supports. There is no more ideal design for tank bottoms than the dome and frustum shape bottom as shown in the illustrations here given.

Concrete, being an ideal building material for compression, is strained to its best advantage in this type. The inner dome is under compression in every direction, and the frustum or outer dome is in compression in one direction and in tension from water pressure in the other direction. At the junction of the inverted dome and the inner dome, the thrust from these two domes may be balanced by the adoption of proper inclinations and sizes of the domes, or there may exist a tension in the ring by the thrust of the inner dome being greater than the thrust of the outer dome, or there may exist a compression caused by the thrust of the outer dome being greater than that of the inner dome. In most cases there is at this region a very massive ring of concrete to take care of eventual changing conditions, for the tank empty, for the tank half full, or for the tank filled to its top. This ring may be supported by four or more columns according to the size of the tank, in which case the ring must serve also as a girder and must be designed accordingly. On account of the comparatively small spans and great loads, these girders are designed mostly for shear and less for bending, and it thereby lends itself readily to architectural treatment, as the rational form of such a grider is really an arch on top of the support. Where only four columns are used, this grider is subjected to a considerable torsional moment, and must be designed accordingly.

Another way of supporting the ring at the junction of the two domes is to support it on a shell of concrete, or, as it is preferred in Europe, of brick or stone. If the shell is built of brick or stone, it is rarely made less than 18 to 24 ins. thick, and, although offering opportunity for elegant architectural treatment, it is very much more expensive than reinforced concrete shells, which can be made very much thinner.

A very cuch larger tank of the second type was recently designed and built by Mr. Mensch for the city of Berlin, Ontario. The construction of this tank was begun in August and completed in November of this year. The tank has a capacity of 600,000 U.S. gals. The details of design of the tank are shown in Figs. 1 and 2.

As will be seen from Fig. 1, the tank is supported by a reinforced concrete shell 75 ft. 11 ins. high and 12 ins. thick. This supporting shell rests upon a circular beveled ring foundation 13 ft. wide on its base and 18 ins. wide on its upper face. The two main parts of the tank bottom are referred to as the inner and outer domes. The inner dome is a portion of the surface of a sphere of 27 ft. radius. The outer dome is the frustum of a right circular cone. The inner and outer domes intersect at the top of the supporting cylindrical shell. The tank proper is 50 ft. in inside diameter. The depth of water in the tank when full is 39 ft., measured from the median plane of the base to the elevation of the overflow. The tank shell is a cylinder 41 ft. high with 12-in. walls. The roof is a portion of a spherical surface 4 ins. thick. The total height of the structure from the top of the foundation ring to the top of the roof is 127 ft. 4 ins.

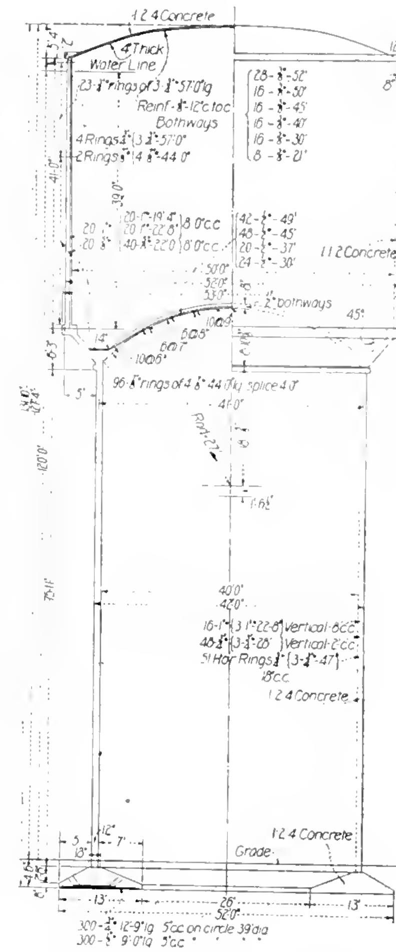


Fig. 1. Sectional Elevation of Concrete Water Tank for Berlin, Ont.

The supporting shell is made incidentally to house a booster pumping unit composed of a turbine pump direct connected to an electric motor. This pump is held in reserve for use in case of very heavy water consumption when the pressure on the mains produced by the head of water in the tank may become insufficient in the higher zones of the distribution system. This pump is placed in operation by automatic electric control from a remote point. In addition to the pumping unit the supporting shell houses the regulating device which controls the admission of water to the tank.

The lower shell is provided with a door and several windows. The ladder to the tank rises from the floor of the pump-room and extends, inside the supporting shell, to an opening 2 ft. 6 ins. by 5 ft., which is made in the shell just below the tank bottom. Outside the shell at the level of the bottom of this opening there is a platform 2 ft. 6 ins. by 7 ft., which is supported on brackets from the shell. An outside ladder extends from this platform to a manhole opening in the roof of the tank.

The inner dome varies in thickness from 14 ins. to 8 ins. The outer dome varies from 12 ins. to 10 ins. A large scale detail drawing of the intersection of the two domes is shown herewith in Fig. 2. These two domes are so proportioned that their thrusts nearly balance. At the junction of the outer dome and shell of the tank there exists a great outward thrust from the weight of the shell of the tank and of the roof, which necessitated the placing of a large amount of steel, and in order to secure the co-operation of the steel and the concrete there was provided a section of concrete at this junction of 18 ins. by 30 ins.

The reinforcing of the tank consisted of ⅞-in. and ¾-in. square bars of high carbon steel. They are placed in two

separate layers where the spacing is less than 4 ins. At the junction of the two domes, a great excess of concrete was provided to take care of the thurst of the outer dome while the tank was empty or partially full. The reinforcing of the inner dome consists of ½-in. rods placed on 6 to 8-in. centres. These rods were provided to take care of stresses, due to the elastic deformation; otherwise the dome is stressed in both directions in compression only, and would not require any reinforcing.

A mixture of concrete of 1:1:2, or slightly richer, was used in all portions of the tank in direct contact with the water. All other concrete consisted of a mixture of 1:2:4. The lower sheel was built by means of wooden forms 6 ft. deep, which were suspended from 1-in. rods imbedded in the concrete, and 8 ft. apart. These 1-in. rods served as a support for a hollow screw, the turning of which moved the forms up. It was found, however, that not more than 4 to 6 ft. could be concreted in any day.

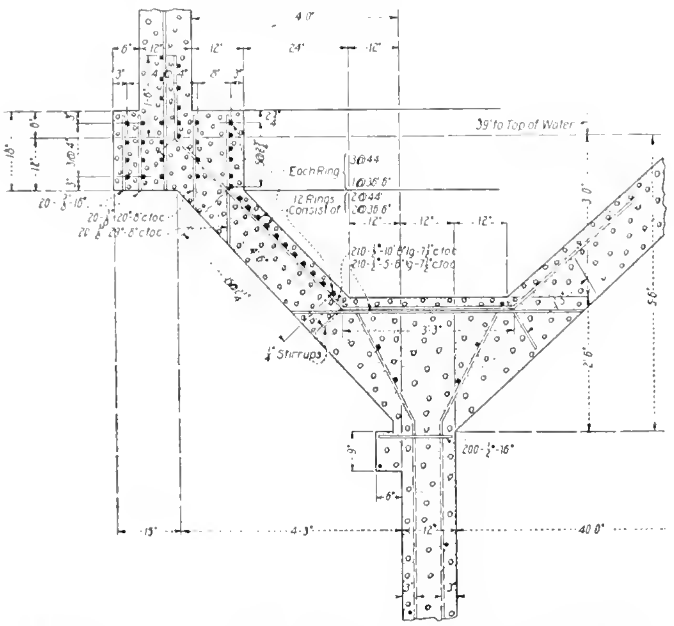


Fig. 2.—Detail of Concrete Reinforcement at Intersections of Outer Dome, with Inner Dome and Tank Wall.

The forms for the inner dome and outer dome were supported on 6-in. by 6-in. Norway pine posts about 10 ft. centre to centre. The forms for the concrete tank were built of 20 sections 3 ft. 1 in. high and 8 ft. long. The outside forms were kept from spreading by common tank hoops. Two sets of these forms were used, one on top of the other, so that one form always served to support the next while being set up

In order to prevent a leak at the junction of two days' work, due to careless removal of laitance or insufficient tamping of the new concrete, a dam or sheet steel 6 ins. wide and No. 28 gauge was imbedded 3 ins. in the concrete at the end of each day's work. These dams came in lengths of 82 ft., which is one-half the circumference of the tank. The roof forms were supported on 4-in. by 4-in. uprights about 8 ft. centre to centre. As they were 44 ft. long, they were braced in two directions every 10 ft.

The concrete plant consisted of a Chain Belt mixer placed near the centre of the tank, which discharged the concrete into a hoisting bucket. The bucket ran inside of a wooden tower, which was built of four 4-in. by 6-in. uprights suitably braced and 140 ft. high. It was raised by means of a hoisting engine placed about 50 ft. from the centre of the tank and outside of the structure. The hoisting bucket discharged the concrete into a hopper, which was also placed inside of the hoisting tower, and from here was spouted through a system of pipes and flexible spouts into place. The hoisting tower placed in the centre necessitated an opening in the bottom and the roof of the tank. These openings were closed and concreted after the rest of the structure was finished. The contract cost of the tank was $23,500.

In the opinion of Mr. Mensch designer and builder of this tank, there are two reasons for the comparatively rare use of concrete for elevated tanks, namely:—

First, because of the inexperience of engineers and contractors in designing and building an absolute water-tight structure of concrete. In a reservoir, which is placed on the ground, wet spots in the walls, or even slight leaks, are not very objectionable, while in elevated structures they are sources of danger from frost, and decidedly unsightly. While wet spots and slight leaks are often overlooked in wooden and steel tanks, they are sources of anxiety in concrete tanks.

Second, because the cost of a concrete structure of this character is, as a rule, considerably higher than that of a steel structure.

Elevated concrete tanks possess some points of advantage, however, over steel tanks. An important advantage of concrete tanks for service in northern climates is that their thick walls prevent, to a considerable extent, the formation of ice within the tank. Under unfavorable conditions of weather and protection from freezing, ice formed within large tanks sometimes attains a thickness of 5 ft. or more. Other points of advantage of concrete tanks are that they do not require painting, and that from the nature of the construction material employed ornamental effects are readily available for slight additional cost.

The tank herein described was built as one part of the extensive improvements to the water works system of Berlin, which have been made during the past year. Messrs. Bowman and Connor Consulting Engineers, of Berlin and Toronto, planned these improvements, with the exception of the water tank. The design of the tank was checked by Mr. Connor.

The length of the Esquimalt Graving Dock at Victoria dock to gate is 450 feet, level with keel blocks; 480 feet with gate on outer kerb. The width of gates is 65 feet. The depth of water varies from 27 feet to 29 feet 6 inches at springs, according to the season of year. The use of the dock will be subject to the following tariff:—

Gross tonnage of vessel.	For the first day of docking.	For each following day, including undocking day.
For all vessels up to 1,000 tons	$300.00	5 cents per ton.
From 1,000 to 2,000 tons	350.00	4½ cents per ton.
For all vessels above 2,000 tons	400.00	4 cents per ton up to 2,000 tons and 2 cts. per ton on all tonnage above 2,000.
Vessels from 430 to 450 ft. in length	550.00	
Vessels from 450 to 480 ft. in length	700.00	

Possessing a large quantity of paper-making woods, British Columbia affords a promising field for the paper-maker. Pulpwood forests border the ocean and many navigable waters, simplifying transportation, and there are numerous water-powers to supply motive power to the mills. The rapid denudation of the pulp areas of the United States will soon compel it to look to Canada for its supply of wood pulp, which, according to the regulations now in force, must be manufactured in the province. There is, besides, a present demand for pulp in Japan, China and Australia, and when the industry is fairly developed, the ocean freights will enable profitable exportation to Great Britain and Europe.

SEWAGE DISPOSAL.*

By J. Darlington Whitmore.

In preparing this paper on Sewage Disposal, I have not considered it necessary to review all the various methods now adopted, but have confined my remarks to that method which seems most applicable to our province and peculiar local conditions, and as this is a maiden paper for a maiden society I must ask your forbearance for any maidenly coyness that may permeate the following lines.

Sewage disposal methods rightly commence on the property of the producer, and I therefore propose to glance lightly over an imaginary scheme, commencing at an imaginary household and following the sewage to its reception and treatment at the disposal works.

I shall not in this present paper deal with other than water borne sewage; the outside closet and privy, etc., together with the objectionable methods of emptying and cleansing same, being thoroughly familiar to us all.

As you are all no doubt aware, the close of the year 1909 saw the ratification of a very excellent Public Health Act for this province, patterned largely upon the laws and regulations enforced by the various local government boards of Great Britain, and controlling the methods of sewage disposal and water supply, as also the pollution of streams and waterways.

The authority is vested in a "Bureau of Health" acting for the government and having a duly qualified medical man at its head as commissioner, who in turn has a sanitary engineer on his staff to advise with him on the various questions that arise.

No scheme for water supply, sewage disposal or sewerage can now be constructed in this province without the sanction of this body, and as time passes and the various plants now completed or under construction come into use, much valuable information will be obtained, and a careful record of regular tests and analyses at the various works will further enlarge our knowledge of this subject and enable us to take a seat in the forefront in the vexed question of the efficient and sanitary disposal of sewage.

Plumbing.—Commencing with the household, our first step in connection with sewage disposal is to install satisfactory plumbing whereby the liquid wastes and fæcal matters are quickly passed away into the sewers without causing any nuisance to the occupiers of the premises.

It has been abundantly proved that, where perfect ventilation in the plumbing system does not exist, the foul gases generated by the sewage and ever present in the pipes will force their way through the water seal of the traps to the interior of the dwelling with a consequence of disease and sometimes death to those persons inhaling the impure mixture.

It is, therefore, absolutely necessary to arrange for perfect ventilation to the whole system and in each case all traps should be back vented with efficient vent pipes and every fixture should be trapped.

The system in vogue for many years, of placing an intercepting trap on each individual system, thereby separating the house plumbing from the sewers, has not borne out the expectations conceived for it and the majority of new systems being or to be installed will be without this fixture.

The idea governing the adoption of the intercepting trap was to exclude sewer gases in the main sewers from rising into habited premises and also to prevent the ingress of rodents; each separate plumbing system was then vented on the house side of the intercepting trap, and it was for a long time considered that the acme of plumbing ventilation had been achieved.

A short vent pipe was connected with the house system close to the intercepting trap, generally in a manhole, whilst the main soil pipe was continued up above the roof; the idea being that the short pipe would always act as an inlet and the long one as an outlet.

This theory was, however, soon exploded, it being discovered that both long and short pipes acted alternately as inlet and outlet, depending upon changes of wind, temperature, etc., and, as the short pipe was always at the lower end of the system, extremely foul odors were ofter discharged at most dangerous points to passing pedestrians, and, where open windows or doors were near the supposed inlet, the malicious influence of the sewer air soon became only too well manifest.

To overcome these difficulties at the supposed inlet end various valves were made, the chief kind being fitted with a mica flap to allow air to enter from outside but to prevent foul air emanating from within; the success attending the adoption of these expedients was but meagre and unsatisfactory and the adoption of this system cannot be recommended.

Personally I consider that efficient plumbing in the interior of dwellings should be as follows: The soil, waste and vent pipes should be of iron, with the caulked lead joint, all fixtures such as baths, sinks, closets, grease traps, etc., should be of porcelain, and through ventilation with the main sewers be always acting; all traps to all fixtures being vented into either a separate anti-syphonage pipe or into the main soil pipe well above the highest fixture; further, the soil pipe should be carried up well above the ridge of the roof and should discharge clear of all chimneys or open windows.

To be certain of satisfactory and air-tight joints in the plumbing at least two tests are necessary, the hydraulic and smoke test. The hydraulic or roughing in test is applied before the fixtures are installed; the pipes including soil, waste and vents being filled with water and allowed to stand a reasonable time; after this test is satisfactorily accomplished and any faults made good, the fixtures are placed, and a smoke test of sufficient pressure so as just not to break the trap seals is further applied; the plumbing after satisfactorily passing these two tests being ready for use.

Sewers.—The sewers can be of either concrete, vitrified tile, vitrified brick or other impervious and smooth construction, and should be so designed as to grade and size as to be self-cleansing.

The velocities of the sewage through the sewers should range from two to six feet per second when flowing half full, and wherever possible should flow by gravity without the aid of pumping.

Where, owing to the topography of the ground, lifting is necessary, it can be accomplished either by some of the various pneumatic devices now on the market or by centrifugal pumps; reciprocating or plunger pumps are not satisfactory for this purpose owing to the excessive wear on the valves and pistons, etc.

In this province the tendency is towards the separate system; the storm water being carried in separate pipes, the advantage of the separate system being that the disposal works can be designed to deal with a known quantity of sewage, and much of the expense and uncertainty attaching to combined systems is thus eliminated.

The ventilation of the sewers is an important feature and should be achieved by through ventilation with all house or

* Paper delivered before Regina Engineering Society, Regina, Sask.

other connections; every separate house connection being untrapped on the main line and thus permitting a free flow of air from the sewers through the house plumbing to the outer air or vice versâ.

It is only reasonable that each householder contaminating the sewers should also provide a means of ventilating them, and without a doubt this offers the best method of ventilation providing the soil pipes are carried up well above the ridge of the roof of any dwelling, and the plumbing is kept in good condition, for which safeguard a compulsory yearly inspection of the plumbing would be advisable.

The practice of ventilating the sewers at the street level through perforated manhole covers as adhered to by many cities and towns, cannot be too strongly condemned, the nuisance arising from such methods being too palpable to the senses of sight and smell.

Up to within about eight years ago I was a firm advocate of the intercepting trap and the ventilation of sewers at the street level, but later observation has changed my views, and I do not consider that any community adopting these methods to-day can be considered as otherwise than behind the times and disregardful of the most obvious laws of health.

Anyone who has walked along the streets of a city or town where the sewers have been ventilated at the street level must have noticed in winter the dense, unhealthy vapor that arises, and in summer they cannot have failed to have become convinced through their olfactory nerves of the monstrosity of this method and its great menace to health and life.

The inhalation of sewer gas will not of itself bring disease unless the sewage is sprayed in it, but it will undoubtedly lower the vitality of the human frame, and so render the body subject to speedy capitulation to the many forms of disease that we humans are heir to.

By ventilating the sewers through the house plumbing the obnoxious gases are carried well up into the air above the roof tops, each house system acting alternately as inlet or outlet, dependent upon the direction of the wind or degree of temperature, and thus carried far away and purified by dilution.

Disposal Works.—The aim of the provincial authorities is to prevent any septic action taking place at the disposal works, and with this end in view the ordinary septic tank is not countenanced, but plain sedimentation has been enforced in all the systems designed under the new Act up to the present time.

This is a very laudable ambition, as a non-septic effluent can be better treated on the bacteriological filters than can a septic fluid, but I do not see how these conditions are to prevail all the year round with our present designs taking into consideration the extreme severity and duration of our winter months.

Beginning with the freeze-up in November, our winters may be said not to terminate till well on into April, and during that period we experience temperatures as low or lower than 50 degrees below zero.

During this period of low temperature it does not appear to me to be either advisable or feasible to empty the sludge from the sedimentation tanks on to the sludge beds as even if the sludge were thus deposited it would freeze into a solid mass and thus neither drain nor dry, whilst it is more than probable that the sludge pipes leading from the sedimentation tanks to the sludge beds would, when operated, quickly become frozen and fail to accomplish their object.

With fresh frozen sludge being deposited on the sludge beds from time to time during the winter, a great mass would accumulate which would take a long time to drain and dry after the winter was over, if it ever did dry, and, I am afraid, would materially interfere with and retard the successful operation of the plant.

If, on the other hand, the sludge is allowed to remain collecting in the sedimentation tanks during the winter months, it will become septic, and the professed object of the provincial authorities will not be obtained with the sedimentation tanks as at present designed.

Fresh sludge from a sedimentation tank contains from 90 per cent. to 95 per cent. water, whereas sludge that is septic contains only 80 per cent. water; it is therefore easy to understand that the removal and subsequent treatment of septic sludge entails much less labor and costs considerably less than that of fresh sludge.

Having in mind the duration and severity of our winters and the difference in volume of fresh wet sludge as against wet septic sludge, I am in favor of a tank so designed that the sludge can be retained for long periods and become septic without coming into long contact with the effluent passing through the tank, and the Emscher tank apparently complies with these requirements with its deep sludge well accommodation.

Septic sludge, being viscous and denser than fresh sludge, is much easier to handle, and both drains and dries quicker, becoming under normal conditions spadable in about five days after being spread upon the drying beds, whereas fresh sludge is very sloppy owing to its large content of water and does not become spadable in less than fifteen to twenty days under similar conditions; it has also a tendency to clog and choke the drainage material of which the sludge beds are composed.

In many of the larger European plants the sludge is drained and dried in pressing machines and centrifuges and afterwards pressed into cakes and used for manure on farm lands, or as fill in low lying ground or sometimes burnt; the grease is also sometimes extracted and sold, but up to the present at a financial loss in most instances

The sludge has but little value as manure and in many cases farmers or others have demanded and obtained payment for removing it from the works.

Personally I am of the opinion that in this province where farmers have not yet attempted to manure the land, that the best and most satisfactory method of disposal of sludge is to burn it in an incinerator after it has been dried upon the sludge beds to a consistency of about 50 per cent. moisture, in which condition it is easily spadable.

For the smaller communities that do not possess garbage incinerators, the dried sludge can be buried in shallow trenches in and reserved for this purpose adjoining the disposal works.

I have spoken at some length on the sludge question, as it is undoubtedly the most troublesome feature to deal with in the modern system of sewage disposal for inland communities, and there is a good sized fortune in store for that individual who can discover some better and more sanitary and economical method of sludge disposal than that which prevails to-day.

Whilst speaking of the sludge it occurs to me that up to the present no attempt has been made to control the fly nuisance that will arise whilst the sludge is being drained and dried upon the beds.

Residual oils sprayed upon the sludge will effectually prevent the fly evil, but at the same time will considerably retard the drying process, and on that account may not be advisable.

For my part, I would favor the construction of a cheap framing around the sludge beds; the openings between the

uprights being filled in with wire mosquito netting and the top roofed over with shingles, the sides having doors for the ingress and egress of the workmen for removing the dried sludge.

This construction would confine the flies to the sludge beds and prevent their wandering into human habitations, and at the same time would allow free access of light and air whilst excluding the rain; the flies could be exterminated from time to time by smoke or other methods.

The severity of our winters has made it debatable as to whether the filters will, without the aid of artificial heat, freeze during the winter months, and to overome this tendency the sedimentation tanks and filter beds have, where possible, been designed under one roof and practically within one enclosure in the hope that the latent heat in the fresh sewage will be sufficient to counteract the frost.

From my personal observations at the septic tanks at Moose Jaw, extending over a period of five years, I found that the temperature of the blanket in the tanks ranged from 40 to 45 degrees Fahr.; the lower temperature being recorded when the air outside the tank registered 40 degrees or more below zero Fahr.; the tanks being of reinforced concrete construction roofed in and covered with a dirt fill of at least two feet on the crown of the arch and increasing towards the haunches and walls.

It remains to be seen whether the latent heat of the sewage will be sufficient to overcome the tendency to freeze in the filters, and I am inclined to the belief that it will, providing proper care is observed in their construction with a view to keeping out the frost. Should the filters, however, show signs of freezing artificial heat will have to be resorted to with its attendant additional outlay and expense.

It is, of course, understood that in locating a site for a sewage disposal plant the topography of the land be well studied with a view to the avoidance of pumping with all its attendant heavy costs, that it be placed as far from the community it serves as possible, and so that the prevailing winds shall carry the odors that will arise, even in the best of plants, away from the city or town.

With this digression I will proceed to describe my imaginary disposal works, which will be typical of those installed in the province up to the present time in conformity with the requirements of the Bureau of Health.

Upon the arrival of the sewage at the works it is received in a screening chamber, passed on into a detritus chamber, thence into a sedimentation tank or system of tanks, from whence it is distributed over bacteriological filter beds, and after emerging, passed into a humus tank where it can be disinfected if necessary before being finally disposed of.

Screening Chamber.—The screening chamber is a small rectangular compartment fitted with bar screens spaced about half an inch apart, the bars being of wrought iron and 1¼ by ½ inch section; in this chamber all foreign substances such as sticks, flannels, scrubbing brushes, corks, matches, hair, etc., are caught and retained and periodically removed and buried or burnt.

Detritus Chamber.—The detritus chamber is rectangular in shape and placed between the screening chamber and the sedimentation tank, being really part of the tank, its capacity is from 3 per cent. to 5 per cent. that of the tank and its functions that of intercepting the heavier mineral matters in the sewage during its passage to the tank.

Were we sure that no sand or other mineral matter would find its way into the sewage, the detritus tank would not be necessary with our separate system of sewage, but we cannot always guarantee that the joints in the tile sewers will remain perfect and it is considered advisable to exclude these substances from the sludge of the sedimentation tanks.

The accumulation of detritus is removed at regular intervals through sludge pipes placed at the bottom of the tank, and is subsequently dried and buried.

Sedimentation Tank.—From the detritus chamber the sewage flows over a long weir into the sedimentation tank by means of a submerged inlet, the tank being so designed as to obtain a large sedimentation of the organic matter in the sewage with a continuous flow of the effluent to the filters.

The velocity of the sewage where it enters the screening chamber is three feet per second, but in the tank it is reduced to one-sixty-fourth of an inch per second, which gives us practically quiescent sedimentation with a continuous flow.

The effluent passes out to the collecting channel through submerged outlets, and no scum boards are used, as their adoption tends to set up currents in the tank.

The tank I have in mind is divided into two compartments and so controlled by valves that either compartment can be used or thrown out of commission at will, thus enabling us to treat the sewage with different durations of contact, or to empty one division for inspection or cleansing at any time without disorganizing the operation of the works.

The walls and floor are trowelled smooth, the latter having a slope of one in fifteen to the shallow sludge pits, to facilitate the gravitation of the sludge.

The rate of flow through the tank is four and three hours respectively, so that if desired for experimental purposes rates of flow of three, four and seven hours can be obtained. The amount of dried sludge extracted from the tank per capita per day is approximately two ounces, depending, of course, largely upon the habits of the persons contributing to the sewage, and as this is increased in bulk nineteen or twenty times by the large amount of water mixed with it, being approximately in the mass 90 degrees to 95 degrees water, weekly extraction of the sludge is necessary to keep the effluent fresh.

For this purpose sludge pipes controlled by cone-shaped valves are carried from the bottom of the shallow sludge pits to the sludge beds, where the sludge is regularly deposited and dried during the seasonable months.

The tank is easy of approach and is fitted with gangways inside so that inspection is at all times easy and can be accomplished without climbing down dark and dirty manholes, or soiling the hands or clothing.

The tank is of reinforced concrete and roofed in as is indeed all other parts of the plant, and a thermometer is kept constantly suspended in the sewage to show the degree of temperature.

The outlet of the tank is fitted with a measuring weir so that the production of sewage can be tabulated and recorded.

Bacteriological Filter.—After passing the measuring weir, the clarified effluent is conducted by a main channel running lengthwise along the centre of the filter, from which subsidiary channels branching off at right angles lead it to a system of Stoddart trays by means of which it is distributed over the filtering material in the form of fine rain drops.

The trays discharge at three inches above the filter, so that no splashing occurs and are laid perfectly level by means of thumb screws affixed to wrought iron chairs.

This method gives a very satisfactory distribution of the effluent and the Stoddart trays have the added advantage of requiring but little attention.

The filtering medium is composed of three-inch crushed stone, well screened and free from dust, and has an average depth of 8 feet, for treating the effluent at the rate of 150 Imperial gallons per cubic yard per 24 hours.

The floor of the filter is of concrete, trowelled smooth with a fall of 1 in 30 towards the centre channel, where the filtered effluent is collected and discharged.

Upon the floor rocks of about 9-inch to 12-inch section are laid to admit of free access of air and easy drainage, and provision for an efficient circulation of air through the filter is further obtained by carrying down from above the ground a set of 12-inch diameter inlet pipes which discharge into the base of the filter and are spaced at 25-foot intervals longitudinally around the walls.

The roof of the filter is further fitted with ventilators for discharging the air, so that good aeration and ventilation are obtained.

Sunlight is admitted through windows in the roof, which are kept open in the summer and closed during winter. The action of this type of continuous filter is aerobic and the degree of purification obtained about 98 per cent.

All operating parts of the filter are of easy and comfortable access and an arched passageway runs along the centre of the filter for its full depth, so that inspection of the collecting channel is obtainable at all times with the aid of a covered lantern.

Disinfecting Channel.—From the filter the now considerably purified effluent is conducted into a long, rectangular channel fitted at intervals with baffle plates, where, if the circumstances so demand, it is disinfected by a minute solution of calcium hydrochlorite which, by means of the baffle plates, is thoroughly incorporated into the effluent, and the whole fully aerated.

Humus Tank.—From the disinfecting channel the effluent flows into a rectangular tank of shallow depth, divided into two longitudinal sections, where it deposits any humus that it may have carried with it during its progress of purification, and from thence is discharged into a small watercourse in a non-putrescible condition, dangerous neither to animal nor fish life.

The tank is fitted with an overfall weir and also floating arms, and one division can be thrown out of use and cleaned whilst the other is operating.

The time of the passage through the tank is twenty minutes to allow of sufficient period for the disinfectant to act.

Sludge Drying Beds.—The sludge drying beds are rectangular in shape, with wide passage ways for the convenience of the workmen who attend to the duties of spreading and drying the sludge and afterwards removing it.

The floors and walls are of reinforced wire mesh concrete to take up the thermal changes, and the floor is laid with a fall of one in ten to the centre to facilitate drainage.

Upon the floor are placed diagonal rows of 4-inch open tile pipes connecting with and discharging into the main connecting channel.

Upon these 18 inches of coarse gravel or crushed stone is placed, surmounted with a six-inch covering of medium sized sand grains, making a total thickness of straining material of 24 inches.

The sludge from the sedimentation tanks and detritus chambers is gravitated to this bed in 9-inch diameter cast iron pipes, and is conducted along the beds in half open channel pipes, from whence it is spread evenly upon the beds in six-inch layers by the workmen and left to drain and dry.

The liquid draining from the fresh sludge is highly putrescible, in contradistinction to that from septic sludge, which is not putrescible, and is conducted by means of the subdrains mentioned to pipes which convey it back to the sedimentation tanks for further treatment.

The sludge, after being dried until it becomes spadable, is removed and buried in shallow trenches upon land reserved for the purpose adjacent to the disposal works.

Conclusion.—I regret that the time at my disposal in preparing this paper has not been sufficient to enable me to prepare any drawings to illustrate my remarks, but I sincerely trust that I have made the various stages of sewage disposal operation sufficiently vivid by word pictures to counterbalance that defect.

The system explained is, as before stated, emblematical of all the new plants so far installed in this province, the only important difference being that the plants at the cities of Regina and Saskatoon have been fitted with revolving sprinkler apparatus for distribution of the effluent upon the filter beds.

In conclusion I would impress upon you that no modern sewage disposal plant, however well designed, is fool proof, and the success of each individual installation is largely dependent upon the care and skill of the attendants. A log should be kept daily of all the happenings at the works and complete records of temperatures, volumes and analyses.

CONCRETE PAVEMENTS TAMPED WITH MECHANICAL VIBRATOR.

Concrete pavements, surfaced with crushed granite and compacted to a high density by means of a mechanical vibrator, have been laid in certain cities in Texas. This method of road building was described by Mr. R. D. Stubbs, contracting engineer, of Dallas, in a paper presented at the ninth annual convention of the National Association of Cement Users at Pittsburgh. A summary of the paper is given below.

Concrete is delivered to the subgrade, after it has been properly shaped and rolled, by inclined chutes from a mixer. The proportions are 1 part Portland cement and 5 parts of aggregate, consisting of sharp sand and gravel. The amount of coarse aggregate passing a ¼-in. sieve should not exceed 40 per cent. nor be less than 33 per cent. The mix is made rather wet.

The surface is brought to the desired shape by means of long-handled floats, and is immediately covered with a coating of crushed granite, graded from ⅝ to 1¼ in. in size. The surface is then ready for the vibratory treatment. Platforms 20 in. wide, made of ⅝ x 4-in. strips, cleated ¼ in. apart, are then placed along or across the street and a movable vibrator is rolled over the road, compacting the concrete to a high density. As the work progresses the platforms are brought forward and the granite surfacing behind is immediately covered with sharp sand and watered. Two or three days later the sand is swept off the surface into the gutter with stiff wire brooms and the street surface is treated with Tarvia. Upon the Tarvia is spread a coating of hard stone from ¼ to ⅜ in. in size. Upon this surface is spread the sand formerly swept into the gutter. The surface is then rolled with a 500-lb. road roller and after the work is seven days old the street is opened to traffic.

Mr. Stubbs states that he employs no bituminous filled joints for the expansion of the pavement, but he does provide for contraction while the concrete is setting by placing on edge on the subgrade at intervals ¼ x 3-in. wooden strips so that these will be buried in the concrete and will occupy the bottom half of the cross section. Within 48 hours after the concrete has been laid, according to Mr. Stubbs, thin, straight lines of relief will appear over the breaker strips. These thin relief lines never exceed 1/16 in. in width. Mr. Stubbs advocates the use of these relief joints only in the case of very dense concrete, but in the case of poured concrete not compacted by vibration he does not favor their use.

THE PRESERVATION OF WOOD BY THE POWELL PROCESS.

Archæologist reports often make mention of the various tactics employed by the ancients in their endeavors to preserve wood, and especially wood that was underground. Probably the Romans brought this art to the highest state of perfection recorded in ancient writings, and this they did by charring the wood on the surface before its interment. Some buried work of the Romans has been unearthed in England after 2,000 years and found to be unaffected. This system is very good for woodwork that is hidden, but for exposed sections is not practical; thus the many preservatives now employed have been introduced with a view of preserving woods employed in the modern arts. One of the methods now being given considerable publicity in England is known as the Powell Wood Process, and is dependent on its working to a discovery made in 1902, when it was found that saccharine matter was a very desirable wood preservative.

The process consists essentially in treating the wood in a saccharine solution, for which wood has a decided affinity. The solutions vary in composition, and to them are added certain other substances to suit the special purpose for which the wood is required. When the wood has been specially dried the process is complete, and the wood is ready for immediate use.

The requisite plant consists of open tanks of suitable dimensions, heated by steam pipes; drying chambers; storage tanks for holding the liquor; trollies, etc.

The timber is not subjected to any external pressure or vacuum at any stage of the process. The wood is immersed in a solution in open tanks. This solution is gradually raised to specific temperatures for certain periods, depending on the size and density of the wood. When the process is completed the wood is removed and placed in a drying chamber. When sufficient desiccation has taken place the wood is ready for use.

The time occupied in the whole treatment, including drying, is in general a few days, though in special cases and for large-sized timber it may be extended to three or four weeks.

The action which takes place is as follows: As the temperature of the solution in which the wood is immersed is raised, the air in the wood expands and the greater portion escapes in a series of bubbles. As a saccharine solution boils at a slightly higher temperature than water, the moisture in the wood is gradually converted into vapor and escapes along with the air. During the treatment the albuminous matter in the wood is coagulated and rendered inert. In some measure this coagulation accounts for the strength of the wood being increased by the process. During immersion, and especially while cooling, the solution is readily absorbed by the wood and penetrates to every part of it.

When the process is completed it is found that the absorbed saccharine matter has been thoroughly assimilated by the tissues, and is invisible either as crystals or syrup, but chemical analysis shows its presence in the tissues, and that it is held in molecular combination with the cellular fibres of the wood.

Complete impregnation of all wood with sacharine matter is effected by this process, though some woods absorb the solution more readily than others, a heavy, close-grained wood taking longer to treat than one with an open grain. The sacharine matter, however, penerates even the hardest woods without pressure of any kind.

"The question whether the timber is impregnated throughout by this process is a most important one. From records to hand it seems that it is so, especially in the case where moderate sized scantlings have been treated."

The cost of treatment is low. For railway sleepers, paving blocks, pier piles and constructional timber generally Powellizing, from the viewpoint of cost, commands every consideration. The process has been used to a considerable extent in the treatment of railway timbers in India and Australia, where it has been found to preserve the sleepers from dry-rot and the attack of insects. A report was made following an examination of several Powellized sleepers, a portion of which reads as follows:—

	Powellized Sleepers			Untreated Sleepers		
No.	No. laid down	Date of laying in open line	Present Condition	No. laid down	Date of laying in open line	Present Condition
1	10	March, 1908	10 still left: cracking a little on top.	10	15th Apl., 1907	1 removed in July, 1910; 2 in 1911-12; 7 cracking.
2	10	Do.	10 still left: much cracked above; good underneath.	10	Do.	1 removed in 1909; 9 fair cracking rather badly.
3	10	Do.	10 still left. 1 may have to be removed this year; 9 cracked beginning from ends, otherwise fair.	10	Do.	1 removed in July, 1910; 3 in 1911-12; 6 gone badly underneath.
4	10	Do.	1 removed in 1911-12; 1 may have to be removed this year; 3 cracking from outside; 5 fair.	10	Do.	All removed in 1909. (Experiment closed.)
5	10	Do	All good; slight cracking.	10	Do.	1 removed in 1911-12; 1 may have to be removed this year; 8 very much cracked.
6	9	Sept., 1907	1 removed in 1909 and 1 in 1911-12; 7 still serviceable.	10 1	January, 1907 Sept., 1907	1 rem'v'd in 1908 and 7 in 1909. (Experiment closed in 1909.

The Powell Wood Process Syndicate, Limited, of 718 Salisbury House, London Wall, London, E.C., hold the patent rights to the Powell Wood Process.

PULP AND PAPER MAGAZINE OF CANADA.

The New Year number of this magazine, published by the Indnstrial and Educational Press, Limited, Toronto, has just come off the press in its enlarged size, and will hereafter appear twice a month, instead of monthly, as formerly. This is the first number from the pen of the new editor, A. G. McIntyre, formerly chemical engineer for Price Bros. & Co., Limited. Mr. McIntyre is a graduate of Acadia University in Arts and Science, and McGill University in Chemical Engineering, and joins this magazine after a wide engineering and paper mill experience.

The year's progress and development are fully reviewed in this number, and many valuable articles are contributed.

Mr. H. S. Ross, K.C., of Montreal, writes an able and exhaustive resume of the Workmen's Compensation Act of Quebec, with references to those of other countries.

The new mills of Price Bros. & Co., Limited, are fully described in an elaborate illustrated article by the editor. The new development of utilization of wood waste for gas producers is discussed by E. B. Archibald, B.Sc., of Montreal.

The Canadian water powers, timber regulations, pulp and paper tariffs, exports and imports, and the entire condition of the trade and its many ramifications are thoroughly dealt with. All this, with the numerous specially contributed technical articles for pulp and paper mill men, combine to make the Pulp and Paper Magazine a true fulfilment of its heading, "A magazine devoted to the science and practice of the manufacture of pulp and paper, with up-to-date news of the allied trades."

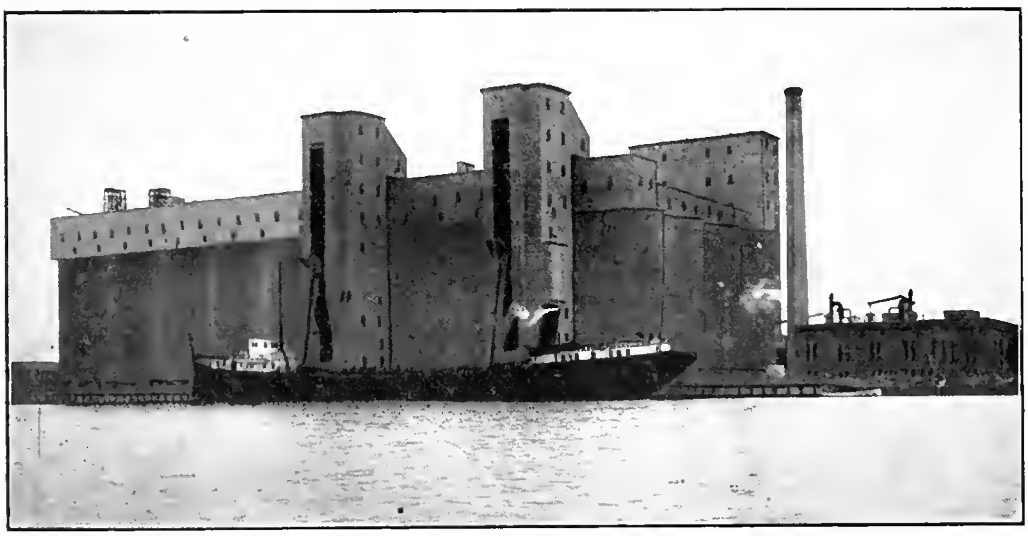
FOUR MILLION BUSHEL ELEVATOR AT PORT McNICHOLL, ONTARIO.

Some time ago we described and illustrated a 2,000,000-bushel elevator which was completed in 1910 by the John S. Metcalf Company, Limited, Montreal and Chicago, for the Canadian Pacific Railway at their new Georgian Bay terminal, Port McNicoll, Ontario. The business proved too large for the elevator by the time the latter had been in operation one year only; and the same engineers were accordingly instructed to build an additional storage unit of the same capacity as the original elevator, making the total capacity 4,000,000 bushels.

The new storage unit, which was completed in time to be entirely filled with the 1911 crop before the close of lake navigation, is a duplicate of the first. It is 179 feet wide, and 226 feet long, making the new length of the elevator 452 feet. Each unit contains 32 cylindrical bins 32 feet 11 inches in diameter, and 31 interspace bins; the bin walls are 80 feet high.

The entire structure is of steel and concrete. The two marine towers, which travel alongside the original elevator, fill the new storage in the same manner as they filled the first unit. The longitudinal conveyers receiving from the marine towers run the entire length of the two units. Grain for shipment from the new portion is conveyed through the basement of the first storage to the car-shipping house.

All machinery is electrically driven, power being generated in a steam plant built in connection with the original elevator.



View of Grain Elevator at Port McNicoll.

The work of the John S. Metcalf Company, Limited, for the Canadian Pacific Railway at this point includes: Two travelling marine towers, capacity 20,000 bushels per hour each; a 4,000,000 bushels fireproof storage; one car-shipping house, 200 cars in 10 hours; a 1,500 h.p. power plant; about 1⅓ miles of wharves; a flour shed, 700 feet long; a freight shed, 700 feet long; customs house; carpenter shop; coal platform; sleeping house for freight porters; eating house for freight porters; pump house; water system for fire protection and general supply.

For the railroad the work has been under the direction of Mr. J. M. R. Fairbairn, assistant chief engineer, and Mr. C. W. P. Ramsey, engineer of construction.

ELECTRIC STEEL REFINING.

A paper read by Dr. Paul Heroult at the recent International Congress of Applied Chemistry, at New York, pointed out that the electric steel furnace has now reached a point when the reduction of costs depends entirely on improvements in detail, both in furnace construction and manipulation. In Europe the process was developed more for the high-priced steels, but in the United States the principal problem has been that of making rails. At the present time the application of the electric furnace for the manufacture of intermediate steel and all qualities of alloy and special steels is established. By the use of the electric furnace the quantity of blowholes and waste can be reduced to a minimum, and saving in the cost of machine work alone would justify paying a very much higher price for electric steel castings, if this were necessary. In the case of many low-carbon high-quality castings made in the electric furnace, it is unnecessary to anneal them, which makes an additional saving in the cost of manufacture. The following tests were given for ordinary mild-steel castings from an electric furnace:—

Test No.	Mn. area. Sq. in.	Reduction of area. Per cent.	Elastic limit per sq. in. Lbs.	Ultimate strength per sq. in. Lbs.	Elongation, Dia. ½ in.
36,138	0.2454	39.5	45,696	71,456	3-in.—28.75%
36,139	0.2359	53.2	33,376	63,616	3-in.—35.00%
					2-in.—34.00%

Analysis.—Carbon 0.12%. Mn. 0.40%. Si. 0.20%. Sulphur and phosphorus below 0.02%.

From these figures it will be seen that it is possible to make a mild-steel casting comparing favorably with plate steel.

Another application of the electric furnace which is of great importance to manufacturers of alloy steel depends upon the fact that any quality of scrap can be worked up and the valuable metals retained. Thus, for example: It is not common in practice to melt up charges of miscellaneous tungsten steel including various tools, turnings, hammer scale and "spillings" from crucibles, all of which contain a certain quality of tungsten. Such a charge can be melted up and the necessary additions made to bring the composition up to the required specification. Chrome, nickel, and vanadium steels for automobile work may also be made in this way in the electric furnace by melting up miscellaneous scrap.

Two years ago it was considered good practice to melt and refine steel scrap in six hours at a power consumption of 750-kw.-hours per ton, whereas at present furnaces are working steadily carrying out the same operation in four hours at a power consumption of under 600-kw.-hours over periods of six months. Similar reductions in operating expenses have been made in all other details.

In this issue will be found the index to *The Canadian Engineer* for the past six months. Attention is drawn to this.

ESSENTIALS OF MACADAM ROAD MAINTENANCE.

W. Huber, B.Sc.

Eternal vigilance is the price of a good permanent macadam road. No matter how much care may be exercised in building it, no matter what the quality of the material used, it can be considered at best but a temporary solution of the good roads problem if at the time of building or immediately thereafter proper provision is not made for its systematic maintenance.

The proper and most economical time to commence the maintenance of this class of road is the day it is opened to traffic. No stone used on road construction is absolutely homogeneous, no bottom is absolutely uniform in its bearing power, and, therefore, no two consecutive sections of road can be considered to have absolutely the same strength. Curious as it may seem, ordinary traffic will sometimes show up small weak spots in a road bottom over which the roller passed showing no indication of their existence, the result of which will probably be a small rut—a rut, perhaps, too small to inconvenience traffic or even to be noticeable to a person driving over it, yet large enough to collect water and soften the surrounding roadway.

Assuming that the road has been properly constructed, i.e., with well compacted sub-grade, properly under-drained, the drains running to free outlets, side-ditches carefully constructed, the road properly crowned and the metal properly bound, the idea of maintenance is to maintain these ideal conditions. As the stability of the new road is in so large a measure influenced by the facilities for drainage supplied, so will the durability of the road depend largely upon the care with which these drainage facilities are maintained. The principal work of the man on maintenance will, therefore, be to keep the drainage both above and under the road as perfect as when it was first constructed. This includes keeping the road well crowned, the sides clean and sloping to the ditches, the side-ditches open and their outlets free, drain and culvert openings clean, and ruts and depressions filled immediately they become noticeable.

The amount of work required in such maintenance will depend, of course, on several factors—quality of material used in construction, nature and amount of traffic, nature of soil, grades, climate, weather, etc.

The system of maintenance should be as simple as possible and not more than two men should be concerned in the work of any one section, viz., the road superintendent and the man actually engaged in the work. Regarding the latter, it is true, as in many other cases, that it pays to have a first-class man, even at a rate of pay higher than paid to one of mediocre ability. He must be a man who can understand the principles on which roads are built for permanency, and who can reason for himself. A man at this work will often be working for days at a time without direct supervision, and he must be a man who can be trusted to do his work and who can also be trusted to find work for himself. A man of this description will save the road superintendent many gray hairs, and will leave him time to devote to his heavier problems.

The equipment required for road maintenance other than complete re-surfacing is simple—a pick, a shovel, a wheelbarrow, a fairly heavy tamping-iron, and a pail being all that is required. There should also be deposited at short intervals on the road-side, small piles of crushed stone and grit. For small repairs the stone may be somewhat finer than the regulation two-inch size used in construction. From one to one and a half-inch will be found most satisfactory. The grit for repair work should be selected for its cementing quality, even more than in construction work. For this work it will be found profitable to secure and store a car of the very best grit obtainable, even at a higher price and freight rate than ordinary grit.

The length of road which one man can properly look after varies with local conditions, but ordinarily a single man can keep from four to six miles in good repair. If it is found that he cannot keep up with the work, his section should be shortened, rather than another man added, as it is found the most economical work is done by men working singly.

The best time for examining the entire length of a section is just after a rain. This will show up all ruts and other depressions, and also any obstructions or lack of grade in side ditches, drains and culverts.

The best method for filling ruts and low spots in the surface is to pick the stone loose in and for several inches around the depression, add a little fresh stone and grit, wet it, and tamp thoroughly. It may be found that traffic will disarrange the stone somewhat, but if it is gone over a few times at intervals of a day or so it will be found to have set and become an integral part of the road, and, if the work has been carefully done, indistinguishable from the remainder of the road. These small depressions should be remedied as soon as they appear, remembering that each one forms a basin for the collection and retention of water which in turn softens the road. This work all resolves itself into an attempt to keep the surface drainage perfect.

Another cause of trouble in macadam roads is the allowing of the earth sides to become cut up and become higher than the edge of the stone, thus impounding water that would otherwise run off. These earth shoulders should be kept trimmed below the level of the stone. In this connection an occasional trip over the road with a split-log or plank drag will be found economical. This will necessitate the hiring of a team for an occasional day, but the expenditure will be well justified, and it will be found that the longer this practice is continued, the less dragging will be required, as the surface of the earth shoulder will become hard, smooth and impervious to water and able to support traffic almost as well as the stone section. In fact, this part of the road, where this method has been followed, is in dry weather often preferable for driving to the macadam section.

The remaining most important part of the maintenance man's work is the keeping of all ditches and drain and culvert outlets open. This work will be heaviest in the spring and fall, when ditches tend to become clogged with leaves and other debris. During the winter special pains must be taken to keep all these water-courses in first-class working order, bearing in mind that the principal idea in winter is to have a course ready for the water as soon as the snow starts to melt. In this as in other work it is easier and cheaper to anticipate trouble than to remedy it after it occurs.

These few points, then, comprise what seem to be the essential features in Macdam Road Maintenance, and if they can be put any more briefly, may be stated as follows:

Start maintenance as soon as the road is built.

Put a good man at the work.

Keep both stone and earth sections smooth and properly crowned.

Remove every obstruction to water running off and from under the road both in summer and winter.

And, lastly, and most important of all—keep eternally at it.

WINNIPEG BUILDERS' EXCHANGE

At the annual meeting of the Winnipeg Builders' Exchange, the financial report of the secretary, Mr. A. M. Rose, showed the exchange to be in flourishing condition. The election of officers resulted in the re-election of Mr. W. J. Davidson as president; Mr. F. Hinds, 1st vice-president; Mr. J. McQuarrie, 2nd vice-president; Mr. Thomas D. Robinson, treasurer; and the following to the board of directors: Messrs. W. P. Alsip, J. W. Morley, H. C. McMartin, and R. W. Paterson. The board is composed of twelve members, four retiring each year.

OIL FOR MACADAM ROADS.

Automobile traffic has revolutionized our ideas of permanent road construction. Whereas a dozen years ago a well-constructed waterbound macadam road was considered about as permanent a road as could be desired for country traffic; with the constantly increasing use of the high-speed rubber-tired automobile, such roads have in many cases disintegrated faster than they could be maintained.

It has been clearly demonstrated that the bond in ordinary macadam road is insufficient to protect it against the somewhat complex action of the automobile tire travelling at high speed. The dust raised by this class of vehicles is blown entirely off the road and a fresh lot of dust raised; this repeated action resulting in the wearing down of the road surface, in some cases several inches in a single season.

While oiling a road is not considered a permanent remedy for this disintegration, it serves to keep the dust down, thus preventing the next lot of dust being raised, and by this means temporarily preserving the road. There are many varieties of oil on the market for this purpose, some of which are little better than water, while others, having a bituminous base, on the evaporation of the volatile constituents, leave a certain amount of bitumen to act as an aid to the binder in the road. This bituminous residue is increased at each successive application, so that as time passes the applications may be made fewer and lighter.

The cost per year of applying oil at current prices, amounts to from eight to fifteen per cent. of the original cost of the road if built by day labor, or from five to ten per cent. if built by contract. This expenditure will be well repaid in the elimination of the dust nuisance and the decreased cost of maintenance, as well as in the increased life of the road.

Cost, per application, of oiling one mile of road, of different widths with varying quantities of material.

Oil, 7½ cents per gallon.

Cost of application, $25 00 per mile.

Width of Road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10ft	5,867	$135	$245	$355	$465	$ 575
12	7,040	157	289	421	553	685
14	8,213	179	333	487	641	795
16	9 387	201	377	554	729	905
18	10,560	223	421	619	817	1,015
20	11,733	235	465	685	905	1,125

Oil, 8½ cents per gallon.

Cost of application, $25 00 per mile

Width of Road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10ft.	5,867	$150	$275	$400	$525	$ 650
12	7,040	175	325	475	625	775
14	8,213	200	375	550	725	900
16	9,387	225	425	625	825	1,025
18	10,560	250	475	700	925	1,150
20	11,733	275	525	775	1,025	1,275

Ordinarily the following applications will suffice:—

First Year—First application, ½ gallon per square yard.
Second application, ¼ gallon per square yard.

Subsequent Years—Two applications, each ¼ gallon per square yard

LUBRICATION OF STREET RAILWAY RAILS.

Water lubrication of street railway rails has been in use for some time on a street in Rome, Italy, carrying heavy traffic. The street is on steep grade and has numerous curves. At the top of the slope a stream of water is fed into each of the four rails of the double track line and flows downhill along the groove of the rail. Every 20 to 30 inches a small wooden block is wedged in the groove, reaching up to wheel flange level, to break the flow of the water. It is reported that cars ride very smoothly on this lubricated track and the grinding noise of cars rounding curves is practically eliminated, while also the general noise of the car traffic is reduced. Grease lubrication at curves is rendered unnecessary.

SMALL WATER POWER WANTED.

A subscriber would like full particulars, with price, of small water powers of about 2,000 horse-power. A firm of carbide manufacturers desires this information. Those interested are invited to correspond with the managing director of The Canadian Engineer.

The Canadian Northern Railway have just signed contracts with builders of rolling stock all over Canada for seven million dollars worth of railway equipment to be delivered during 1913. This will include 130 locomotives, 76 passenger coaches, 300 box cars and variety of other cars. Equipment bonds will be issued for the purpose.

COSTS OF MACADAM ROADS OF DIFFERENT THICKNESSES.

Cost of building one mile of Waterbound Macadam Road of various widths and depths. Comparison of Day Labor and Contract Figures

Day Labor prices based on the following data:
Cost of labor, 20c. per hour.
Cost of teams, 50c. per hour.
Cost of stone, $1.30 per ton, F. O. B., $1.69 per cubic yard.
Weight of 1 cubic yard of Stone, 2,600 lbs.
Average wagon haul, 1 mile. For longer hauls add 25c. per cubic yard a mile.
Total cost in each case includes grading and shaping of road bottom.

MACADAM ROAD, 5 INCHES THICK

Width of Road.	Cubic Yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams Including Grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10 ft	1,000	$1,690	$1,100	$2,790	$4,920	$5,140
11	1,100	1,860	1,210	3,070	5,280	5,520
12	1,200	2,030	1,320	3,350	5,640	5,900
13	1,300	2,200	1,430	3,630	6,000	6,280
14	1,400	2,370	1,540	3,910	6,360	6,660
15	1,500	2,540	1,650	4,190	6,720	7,040
16	1,600	2,710	1,760	4,470	7,080	7,420
18	1,800	3,050	1,980	5,030	7,800	8,180
20	2,000	3,390	2,200	5,590	8,520	8,940
22	2,200	3,730	2,420	6,150	9,240	9,700
24	2,400	4,070	2,640	6,710	9,960	10,460

Day Labor unit prices:

Per square yard, 47½c.
Per cubic yard, $2.79

MACADAM ROAD, 6 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams Including Grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10 ft.	1,200	$2,000	$1,200	$3,200	$5,640	$5,904
11	1,320	2,200	1,320	3,520	6,072	6,362
12	1,440	2,400	1,440	3,840	6,504	6,820
13	1,560	2,600	1,560	4,160	6,936	7,279
14	1,680	2,800	1,680	4,480	7,368	7,737
15	1,800	3,000	1,800	4,800	7,800	8,195
16	1,920	3,200	1,920	5,120	8,232	8,654
18	2,160	3,600	2,160	5,760	9,096	9,573
20	2,400	4,000	2,400	6,400	9,960	10,492
22	2,640	4,400	2,640	7,040	10,824	11,411
24	2,880	4,800	2,880	7,680	11,688	12,330

Day Labor unit prices:

Per square yard, 54½c.
Per cubic yard, $2.67.

MACADAM ROAD, 7 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams Including Grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10 ft.	1,400	$2,333	$1,300	$3,633	$6,360	$6,668
11	1,540	2,567	1,430	3,997	6,864	7,202
12	1,680	2,800	1,560	4,360	7,368	7,737
13	1,820	3,033	1,690	4,723	7,872	8,272
14	1,960	3,267	1,820	5,087	8,376	8,807
15	2,100	3,500	1,950	5,450	8,880	9,342
16	2,240	3,733	2,080	5,813	9,384	9,877
18	2,520	4,200	2,340	6,540	10,392	10,947
20	2,800	4,667	2,600	7,267	11,400	12,017
22	3,080	5,133	2,860	7,993	12,408	13,087
24	3,360	5,600	3,120	8,720	13,416	14,155

Day Labor unit prices:

Per square yard, 62c.
Per cubic yard, $2.59.

MACADAM ROAD, 8 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams Including Grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10 ft.	1,600	$2,667	$1,500	$4,167	$7,080	$7,432
11	1,760	2,933	1,650	4,583	7,656	8,043
12	1,920	3,200	1,800	5,000	8,232	8,654
13	2,080	3,467	1,950	5,417	8,808	9,265
14	2,240	3,733	2,100	5,833	9,384	9,876
15	2,400	4,000	2,250	6,250	9,960	10,487
16	2,560	4,267	2,400	6,667	10,536	11,098
18	2,880	4,800	2,700	7,500	11,688	12,320
20	3,200	5,333	3,000	8,333	12,840	13,542
22	3,520	5,867	3,300	9,167	13,992	14,764
24	3,840	6,400	3,600	10,000	15,144	15,982

Day Labor unit prices.

Per square yard, 71c.
Per cubic yard, $2 61.

MACADAM ROAD, 9 INCHES THICK

Width of Road	Cubic yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams including grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10 ft.	1,800	$3,000	$1,700	$4,700	$7,800	$8,197
11	1,980	3,300	1,870	5,170	8,448	8,884
12	2,160	3,600	2,040	5,640	9,096	9,571
13	2,340	3,900	2,210	6,110	9,744	10,259
14	2,520	4,200	2,380	6,580	10,392	10,946
15	2,700	4,500	2,550	7,050	11,040	11,634
16	2,880	4,800	2,720	7,520	11,688	12,322
18	3,240	5,400	3,060	8,460	12,984	13,697
20	3,600	6,000	3,400	9,400	14,280	15,072
22	3,960	6,600	3,740	10,340	15,576	16,447
24	4,320	7,200	4,080	11,280	16,872	17,822

Day Labor unit prices

Per square yard, 80c.
Per cubic yard, $2.61.

MACADAM ROAD, 10 INCHES THICK

Width of Road	Cubic yards of Material	Day Labor: Cost of Material	Day Labor: Cost of Labor and Teams including grading	Day Labor: Total Cost	Contract Prices Including Grading: Cost at Lowest Contract Price	Contract Prices Including Grading: Cost at Highest Contract Price
10ft.	2,000	$3,380	$1,850	$5,230	$8,520	$8,960
11	2,200	3,720	2,035	5,755	9,240	9,724
12	2,400	4,060	2,220	6,280	9,960	10,488
13	2,600	4,400	2,405	6,805	10,680	11,252
14	2,800	4,740	2,590	7,330	11,400	12,016
15	3,000	5,080	2,775	7,855	12,120	12,780
16	3,200	5,420	2,960	8,380	12,840	13,544
18	3,600	6,100	3,330	9,430	142.80	15,072
20	4,000	6,780	3,700	10,480	15,720	16,600
22	4,400	7,460	4,070	11,530	17,160	18,128
24	4,800	8,140	4,440	12,580	18,600	19,656

Day Labor unit prices:

per square yard 95c.
per cubic yard $2.61

N.B.—These day labor prices do not allow anything for depreciation of plant, management or capital investment.

WATERPROOF CONCRETE.

Some experiments on impervious concrete were made at Husum, Germany, recently in connection with preparations for the construction of a new lighthouse. Various mixtures of cement and fine dune sand in ratios 1:1 up to 1:6 and mixtures of 1:3 with the addition of various waterproofing material such as soft soap, oil and patented mixtures were prepared and were molded into pot-shaped vessels about 15 inches high, with 2½-inch walls. When these pots had set, some of them were filled with water, others (empty) were set into water; and the density of the walls was judged by noting the time required to empty or fill, the water acting under a maximum head of about 10 inches. The experiments showed that a satisfactory degree of imperviousness was not reached, since in every test the vessels filled or emptied within an hour. The relative success of the richer mixtures then induced tests of rich rubbed surfacing. To this end the surfaces were first wet, then thickly coated with cement paste, and with a soft brush the cement paste was then rubbed into the surface of the concrete. Repeating this procedure several times until the pores were closed, a very satisfactory imperviousness was reached, the pressure tests (as above) continued for three days showing no water passing through the walls of the pots. On the basis of these tests it was decided to build the lighthouse substructure of a 1:3 mixture with surface made impervious by the grout-rubbing process as used in the experiments.

EARTH AND GRAVEL ROADS.*

By Robert C. Terrell.†

Earth roads must be well drained and properly crowned, in order to be serviceable at all times. The maintenance of a road thus constructed is comparatively easy and not very expensive if the work is done at the proper time, but good drainage is very costly, if not altogether impossible, unless the road is properly located. A road, in order to be properly drained, must have the proper longitudinal grade; a minimum grade of ½ of 1 per cent., with a maximum grade, generally, of 5 per cent. The minimum grade is necessary in order to give the side ditches the proper amount of fall to carry the water quickly away from the road. Side ditches should never be made deep and narrow. If extra drainage is necessary, roads should be undertaken by use of tile or by excavating a deep ditch and filling with large stones. Where roads are located along side hills a ditch should be dug on the upper side sufficient to take all the water coming down the hill. Where the grade exceeds 5 per cent., the ditch should be paved with stone and the water should be carried under the road from the upper side at short intervals and disposed of.

If the road has been properly located and properly drained, the point of most importance is the crown; the parabola form is the best, having a centre elevation equal to 1/24 of the width of the road. Frequent causes of mudholes are the unevenness in the texture of the soil and the combining of vegetable matter with the soil while working the roads; this vegetable matter holds water, thus damaging the surface. In no case should stone be piled into a mudhole, as it only forms a rough and unsatisfactory surface and permits the formation of mudholes at either end from the impact of loaded vehicles. The road, however, can be successfully repaired by the removing of the softer soils, or soils containing vegetable matters, and replacing with clay, or soil of the same consistency as the remaining portions of the road, and by removing the shade, so that the sun may have free access to that portion of the road.

Earth roads should have their principal working in the spring of the year when the soils will work most readily and will have time to become consolidated before the fall rains begin. A scraping-grader drawn by a traction engine will do excellent work in giving a road sufficient crown. The earth removed from side ditches should not be thrown into the centre of the road.

In the construction of the gravel road, beginning with the sub-grade, it is probably best to open the trench to receive the gravel, giving it the same crown or cross section as the finished roadbed should have, which should be a parabola, with the centre height equal to 1/40 of the width of the road. Gravels containing clay or sand, or even loam, not exceeding 20 per cent. of the entire quantity, make excellent road material and will bind or compact very readily. After the gravel has been properly placed on the sub-grade it should be thoroughly sprinkled and rolled. In western Kentucky gravel roads cost approximately $1,000 per mile. In eastern Kentucky the cost is slightly higher.

In my opinion the maintenance of earth and gravel roads will never be effectively accomplished until we receive government aid for all post roads and until every road becomes a post road. I do not mean, however, by "government aid" that the government shall bear the entire or major portion of the expense of constructing and maintaining roads, but that the government will merely assist in the construction and maintenance of roads to such an extent as will enable the government to direct the local authorities how the work must be done before the federal aid is available, and then that these roads be put under direct government inspection by making each and every rural mail carrier the inspector of his route, reporting deficiencies in the road as they occur to the local authorities and to make reports to the federal government once each month as to the condition of the road.

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Commissioner, State Department of Public Roads, Kentucky.

CANADA IMPORTS MUCH CLAY.

Canada's clay imports are classified by the department of customs under three main subdivisions: clays, brick and tile, and earthenware and chinaware, and their total value is shown as $5,156,544, or 62 per cent. of the domestic production, in the annual report of Mr. J. McLeish, B.A., chief of the division of mineral resources and statistics. The imports of clays in 1911 were valued at $270,247, and included chiefly china clay and fire clay, with a small quantity of pipe clay, and others clays not classified. The value of china clay imports was $125,768, and of fire clay, $125,199.

The imports of these clays have varied considerably from year to year, and do not show the same general increase as do the imports of manufactured clays. The imports classified under brick and tile were valued in 1911 at $2,369,761, of which about 34 per cent. was firebrick, other important items being building brick, sewer pipe, and paving brick.

There was also an importation under this class of manufactures of clay not specifically designated, valued at $523,998. The imports of these "unclassified" brick and tile have increased steadily year by year, the value of such imports in 1905 having been only $20,804. The total imports of brick and tile in 1910 were valued at $1,755,773, showing an increase in 1911 of about 35 per cent.

The imports of earthenware and chinaware, of which the most important class is tableware, were valued in 1911 at $2,516,536, as against $2,283,116, an increase of about 10 per cent.

There is also a considerable annual importation of "chalk, china or cornwall stone, cliff stone and feldspar, fluorspar, magnesite ground or ungronnd," much of which is no doubt used in connection with the manufacture of clay products.

The value of these imports during 1911 was $147,640; of which $90,119 was from the United States, $54,548 from Great Britain, and $2,973 from other countries. The value of the imports under this item during the calendar year 1910 was $121,959.

There is also an annual importation of "baths, bath tubs, basins, closets, lavatories, urinals, sinks, and laundry tubs of any material," the value of such imports during 1911 being $285,847, as compared with $262,667 during the year 1910.

Imported clay products are derived chiefly from Great Britain, and the United States, although considerable quantities of earthenware, china, and porcelain ware, white granite or ironstoneware, etc., are brought from Germany, France, Austria-Hungary, and Japan.

Of the brick and tile imported, 76.7 per cent. was from the United States and 23.2 per cent. from Great Britain; and only $578 worth from other countries.

Of the earthenware and chinaware, 62 per cent. was imported from Great Britain; 15 per cent. from the United States; 9 per cent. from Germany; 7 per cent. from France, and considerable values also from Japan, Austria-Hungary, and other countries. The crude clays were imported principally from Great Britain and the United States.

COAST TO COAST.

Victoria, B.C.—The water report for the council of this city will be completed within a few days.

Port Arthur, Ont.—The past year has been a season of activity in the municipal engineering department, and the expense account for general work totals $584,027.

Calgary, Alta.—Colon bacilli has been found in certain sections of the water supply on this city and the medical health authorities have issued warnings to the citizens concerning the same.

Hamilton, Ont.—Mr. C. H. Mitchell, of Toronto, and Prof. Hutt, of the Ontario Agricultural College, Guelph, addressed a large gathering in this city recently on the subject "The Beautification of the Mountain Park."

Montreal, P.Q.—The Harbor Commissioners of Montreal have awarded the John S. Metcalf Company, Limited, a contract for a 1,500,000-bushel addition to the Harbor Commissioners' Elevator No. 1 at Montreal. It will be of reinforced concrete and steel and will cost approximately $700,000. This will make the capacity of Elevator No. 1, 2,500,000 bushels, as compared with 2,000,000 bushels' capacity in the new Elevator No. 2 recently completed by the John S. Metcalf Company.

Eastern Central Canada.—Col. Greenwood, assistant chief engineer of construction on the Canadian Northern's eastern lines, states that rapid progress is now being made on the company's four large bridges now being constructed between Montreal city and Pembroke, at a total cost of about $1,250,000. They are being built over the rivers Laprairie or Back River, the Mille Iles, and the Ottawa at Shaw Falls, and at Portage du Fort. All the sub-structures of these bridges are of concrete, while the superstructure will be of steel, and which will be placed in position during the coming summer. No. 1, which crosses the Back River near St. Genevieve, has eight spans, and is about 1,400 feet in length, while No. 2 has thirteen spans in all, and strikes the Mille Ile after crossing the upper end of Ile Jesu, which at this point is about one and a half miles wide. The structure at Shaw Falls will be 1,800 feet in length, and that at Portage du Fort some 1,300 feet, so, taking the whole four, they make a series of very formidable structures and will all be on the C.N.R.'s main line from Montreal to the harbor of Prince Rupert.

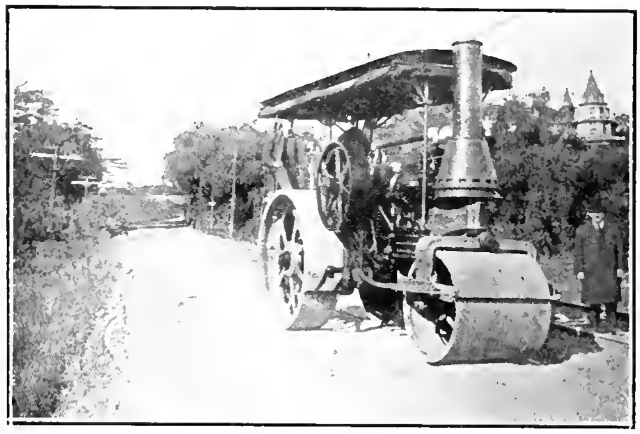
GASOLINE ROAD ROLLERS.*

As far as Ontario is concerned, Gasoline Road Rollers are an inovation in road building machinery.

When making their purchases in 1911, the Commission were recommended to purchase Steam Road Rollers. The Engineer for the Commission took the stand that the steam machines were better known and operators for steam machines could be more easily procured, and, further, that the life of the Gasoline Road Roller was not yet known.

During 1911, and the spring of 1912, all the available information on Gasoline Road Machinery was studied, and when the purchasing of machinery for 1912 was under advisement, Gasoline Machinery was carefully considered, with the result that it was decided to purchase one 12-ton 2-cylinder Gasoline Road Roller.

The advantages claimed by the sales agent for Gasoline Road Rollers are outlined in the catalogue. Amongst them may be found the absence of smoke, sparks, and the risks of boiler explosion. The expense of teams for hauling coal and water is done away with. There is a saving of an hour in the raising of steam and half an hour in closing down. There is some saving through the day, because the engineer has not to fire and take on water. Claim is made by some salesmen that the machinery is much quieter, and not so apt to scare horses on the highway and the grade, as a steam roller; but we might say that in our short experience we do not find much gain in this connection.



Double Cylinder Gasoline Roller Working on the Kingston Road.

We have now had two seasons in which to compare the cost of operation of the steam and gasoline machinery, and the following table will give the comparison of cost, as nearly as can be judged, both rollers working under similar conditions:

COST OF OPERATING STEAM ROLLER.

For Ten-hour Rolling.

Fuel—	
Kindling wood	$0.05
Coal, 380 lbs. at $6.85 per ton	1.30
Water—	
600 gallons—Hauling three hours at, per hour, 50c.	1.50
Oil, etc.	0.05
Engineer—	
11½ hours at 30 cents per hour	3.45
	$6.35

Cost of rolling, 63½c. per hour.

For Ten Hours' Spiking and Scarifying.

Fuel—	
Kindling wood	$0.05
Coal, 480 lbs. at $6.85 per ton	1.64
Water—	
800 gallons, hauling	2.00
Oil.	0.05
Engineer—	
11½ hours at 30c.	3.45
	$7.19

Cost of spiking and scarifying, 71 9/10c. per hour.

COST OF OPERATING A GASOLINE ROLLER.

For Ten Hours' Rolling.

Fuel—	
12 gallons of gasoline at 15c. per gallon	$1.80
Water—	
Cooling quarter hour	0.12½
Oil.	0.07
Engineer—	
10¼ hours at 30c.	3.07½
	$5.07

Cost of rolling, 50c. per hour.

* Abstract from 1912 report of the Board of Highway Commissioners, York County, Ontario.

For Ten Hours' Spiking and Scarifying.

Fuel—	
20 gallons of gasoline at 15c. per gallon	$3.00
Water—	
For cooling	0.15
Oil	0.07
Engineer—	
10¼ hours at 30c.	3.07
	$6.29

Cost of spiking per hour, 62 9/10 cents per hour.

The saving which is shown on the work in favor of gasoline has been in its constant operations. We gain from one to two hours a day of actual operations with our gasoline roller.

When we first purchased these machines we were afraid they would be difficult to start in cold weather, but this has not been the case.

The gasoline road roller has not been in operation long enough in Canada for us to be sure of just what it will do, but the success that has accompanied the gasoline engine in other fields of operations would indicate that it could be successfully operated in connection with road roller work.

GRAND TRUNK PACIFIC CONSTRUCTION.

The work accomplished by the Grand Trunk Pacific Railway for the twelve months ended December 20th is contained in the chief engineer's annual report issued in Winnipeg. It shows that construction has been undertaken on 563 miles of main line, and on 688 miles of branch lines, making a total of 1,251 miles of line on which clearing, grading and track-laying have been done. Track has been laid on 128 miles of main line, and on 331 miles of branch lines, making a total of 459 miles of railway completed exclusive of second tracks and sidings.

On the section known as "main line Winnipeg west," grade is now completed to mile 1,124, Rau Shuswap crossing, and track should be laid to that point before the close of the year. The line is in operation from Winnipeg to Tete Jaune Cache, mile 1,095. From the Rau Shuswap crossing at mile 1,124, westerly to mile 1,403 (Endako river crossing), the right of way is being cleared and at those points where clearing has been completed, active grading operations are under way. For instance, the grade from Rau Shuswap crossing to the second crossing of the Fraser river at mile 1,190, should permit of track laying in the space of a month or two.

From Prince Rupert easterly the track is laid to mile 189, being held up at that point, owing to the erection of steel bridges. Eighty-nine miles of this track were laid during 1912, and the line is in operation to Hazelton. From mile 189 to the Endako river crossing (mile 341 Prince Rupert, or mile 1,403 Winnipeg), active grading operations are in progress.

Harte to Brandon—Grading is under way on this branch and although 10.8 miles are ready for track no steel has yet been laid. The total length of this branch is 25 miles. Regina to international boundary, only the last 19 miles of this line require to be graded. The track is laid for 106 miles, and was all put down this season.

Prince Albert Branch—This line extends from Young on the main line, and is in operation from that point to Wakaw, a distance of 67 miles. No track was laid in 1912. A large steel bridge has yet to be erected over the South Saskatchewan river, but with the exception of the entrance into Prince Albert the grade is practically completed.

Tofield to Calgary—This line is 202 miles long. A few steel bridges have yet to be erected but grading is almost completed. During 1912 steel was laid from mile 07 to mile 165.3, and the track will be continued to Calgary in the early spring of 1913. The line is in operation to mile 62.

Other branch lines reported upon are the Talmage-Weyburn line, 15 miles in length, of which 39 per cent. of the grade is completed; and the Regina-Moose Jaw connection, of 49 miles, which is now completed, and its terminals at Moose Jaw in course of construction. Grading is completed on Moose Jaw-Northwest branch, but no steel has been laid. All the track on the Oban-Battleford branch was laid during 1912, and the line, 48.5 miles in length, is now completed. The Cut Knife branch from Battleford westerly toward Wainwright is finished, so far as grading is concerned, and four miles of track are laid. Steel will be laid throughout its length in the early spring of 1913. A branch line is surveyed from Biggar to Calgary, and it is stated by the chief engineer that for the present time this line is only being constructed as far as the Saskatchewan-Alberta boundary, a distance of 104 miles from Biggar. Grading on this portion was completed in 1912, and steel is laid to mile 37. The Alberta coal branch, which extends 56 miles southerly from Bickerdike on the main line, is graded for the whole of its present length.

PERSONAL.

FRANK BARBER, consulting engineer, Toronto, has quite recovered from his recent illness, and is able to look after all his work.

O. H. HOOVER, B.A.Sc., is at present located at Moose Jaw, Sask. He has taken charge of the hydrographic work in the Moose Jaw district for the present winter.

W. K. TASKER, formerly superintendent of the Pere Marquette R.R., at Saginaw, Mich., has been made superintendent of the Canadian division with headquarters at St. Thomas, Ont.

F. A. CREIGHTON, who has been city engineer of Prince Albert, Sask., since July, 1907, tendered his resignation at the final meeting of the city council. It is probable that he will locate in private practice in Winnipeg.

PHILIP P. SHARPLES, chief chemist, Barrett Manufacturing Company, Boston, on December 30th delivered an illustrated lecture on the "Manufacture of Refined Coal Tar," before the graduate students in Highway Engineering at Columbia University.

N. H. MANNING, a graduate of the Faculty of Applied Science and Engineering, of the University of Toronto of the class of '09, is the Toronto district representative of the Canadian Inspection and Testing Laboratories, Limited, 25-27 Manning Arcade Annex.

J. W. EBER has been appointed to the position of general manager of the Toronto, Hamilton and Buffalo Railway Company. Mr. Eber was formerly general superintendent for the same company; that position is now abolished. His headquarters will be Hamilton, Ont.

JAMES B. GOODWIN, recently superintendent of construction and assistant general manager of the Mount Hood Railway and Power Company, Portland, Ore., has been appointed construction engineer for the city of Edmonton, Alberta. Edmonton proposes to do a large amount of new work in the coming year.

LIEUT.-COL. WILLIAM PATRICK ANDERSON, of the Dominion Department of Marine and Fisheries, who has just been honored by King George with a C.M.G., was born at Levis, Quebec, in 1851. He was one of the charter mem-

bers and subsequently president of the Canadian Society of Civil Engineers. He was the founder of The Canada Militia Gazette, and has had a long and distinguished military service. For many years he was member and chairman of the Ottawa School Board.

OBITUARY.

MR. JOHN J. McDONALD, a former assistant engineer of Medicine Hat, Alberta, died recently in that municipality. He was 32 years of age and came to Western Canada about six years ago, and has held several important civic and government engineering positions. His home is in Glace Bay, N.S. Heart failure is given as the cause of death.

COMING MEETINGS.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE. Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase, Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Jan. 16, 1913 Contents of this issue on page 179

The Canadian Engineer

An Engineering Weekly

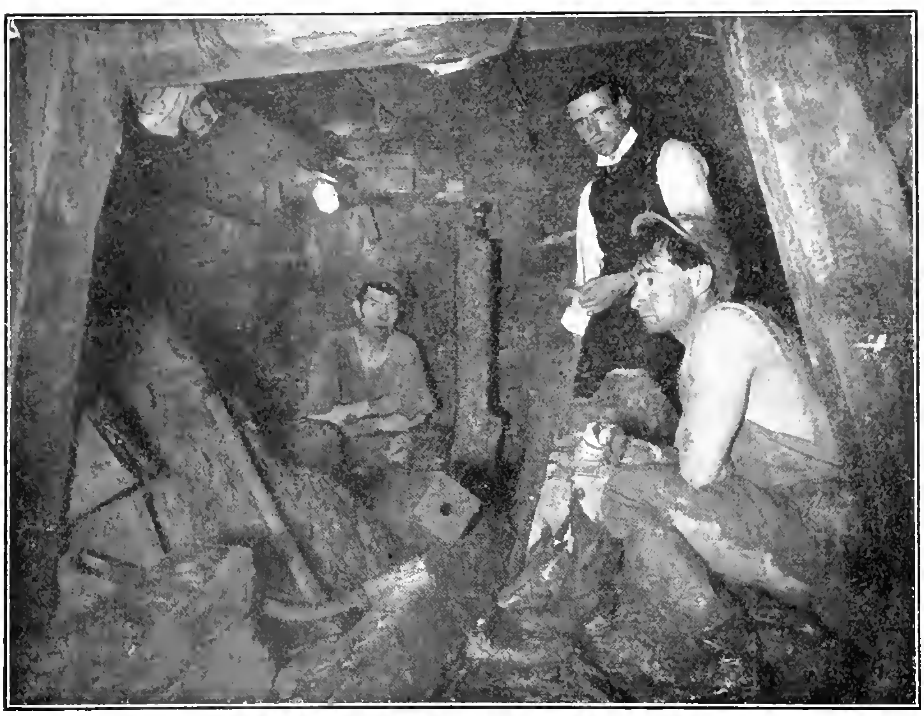
CONSTRUCTION OF A CONCRETE SEWER TUNNEL THROUGH DIFFICULT GROUND.

By H. S. PHILIPS, Resident Engineer.

The sewer described in this article, and known as Barton Section 1, forms part of a system of storm overflow sewers provided to relieve the congestion of the existing sewers in the western section of the city of Toronto, known as the Garrison Creek drainage area.

The existing sewer for which relief is provided by this storm sewer is that running along Bloor Street easterly from the Garrison Creek (at Willowvale Park) to Huron Street. Floodings were experienced in cellars of houses and stores during heavy rains, and in view of the immediate addition of the northern districts, the necessity for relief became more urgent.

The general scheme of existing drainage of the area in question is that of tributary sewers extending from south to north, with main sewers running east and west. These main sewers discharge into the Garrison Creek, which runs practically north and south, discharging into the lake at the south end.



Heading at Station 28 + 00, Abandoned at Station 28 + 28.

The question of paralleling, in order to relieve Bloor Street Sewer, was considered out of the question on account of the busy nature of the street, and the presence of the street railway tracks. Other utilities underground were numerous and formed obstructions. The geological formation was found to be bad for sewer construction in tunnel, involving running sand, clay and water pockets, boulders, etc. The idea of open cutting could not be entertained owing to the obstructions and street traffic. On these accounts it was decided to place the sewer on Barton and Lowther Avenues, to the north, although the subsoil, as indicated by borings, was equally bad, being of glacial deposit formation, as in Bloor Street, but the streets were not so hampered with excessive traffic, and in the event of open cutting having to be resorted to, would inconvenience little.

The total area drained by the Barton Avenue sewer is 701 acres, and extends some 670 feet north of the C.P.R. northern line. The whole area has a fall from north to south and is practically level from east to west.

The existing sewers and those new sewers required for future drainage run along the north and south streets, discharging into Bloor Street at the south end. The system is the "combined."

The method of interception is that of tumbledown shafts, as shown in Fig. 2, with tumbledown C. I. pipe shoots for the smaller sewers and the sanitary flow of the larger ones. The whole flow, sanitary and storm, is intercepted and carried in the storm sewer. Separation of the sanitary and storm water is provided for at Bloor Street on the Garrison Creek sewer. The channel provided for the sanitary flow in the storm sewer is shown in Fig. 2.

The total length, including section 2, is 7,741 feet; section 1, to which this article refers, is 3,345 feet long and is at the outlet end of the sewer.

Fig. 2 shows the typical cross section of the sewer as carried out. The flat section was designed to same height across the low-lying land of Willowvale Park, so that mounding would not be necessary. The remaining sections gradually increasing in size towards the outlet, are designed for tunneling so that the invert can be placed, as conditions per-

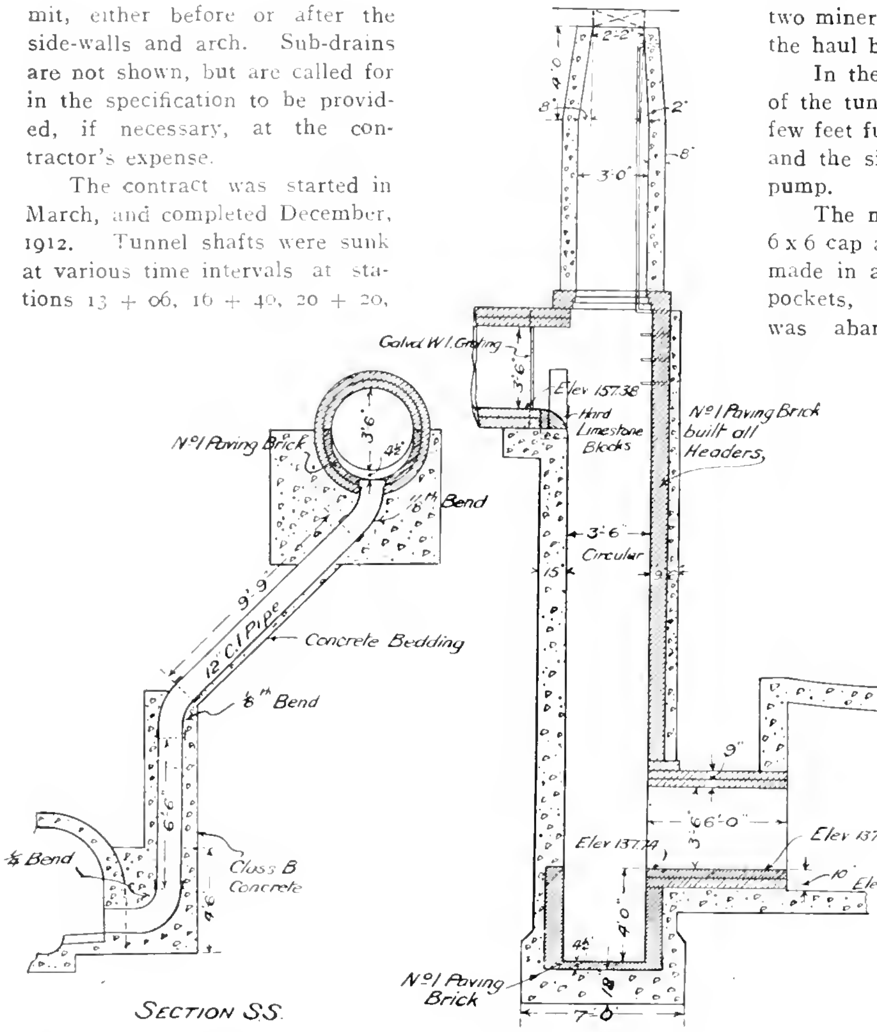
mit, either before or after the side-walls and arch. Sub-drains are not shown, but are called for in the specification to be provided, if necessary, at the contractor's expense.

The contract was started in March, and completed December, 1912. Tunnel shafts were sunk at various time intervals at stations 13 + 06, 16 + 40, 20 + 20, 23 + 06, 26 + 00 and 31 + 20, numbered respectively 6, 5, 4, 3, 2 and 1, and headings were driven east and west from all shafts. The depths of the shafts are as follows: No. 1, 34 feet; No. 2, 35 feet; No. 3, 35 feet; No. 4, 37 feet; No. 5, 35 feet; No. 6, 31 feet deep. The shafts for manhole and tumbledown shafts at Christie Street were 33 and 44 feet deep respectively. The open cut part has a varying cover from two to eight feet.

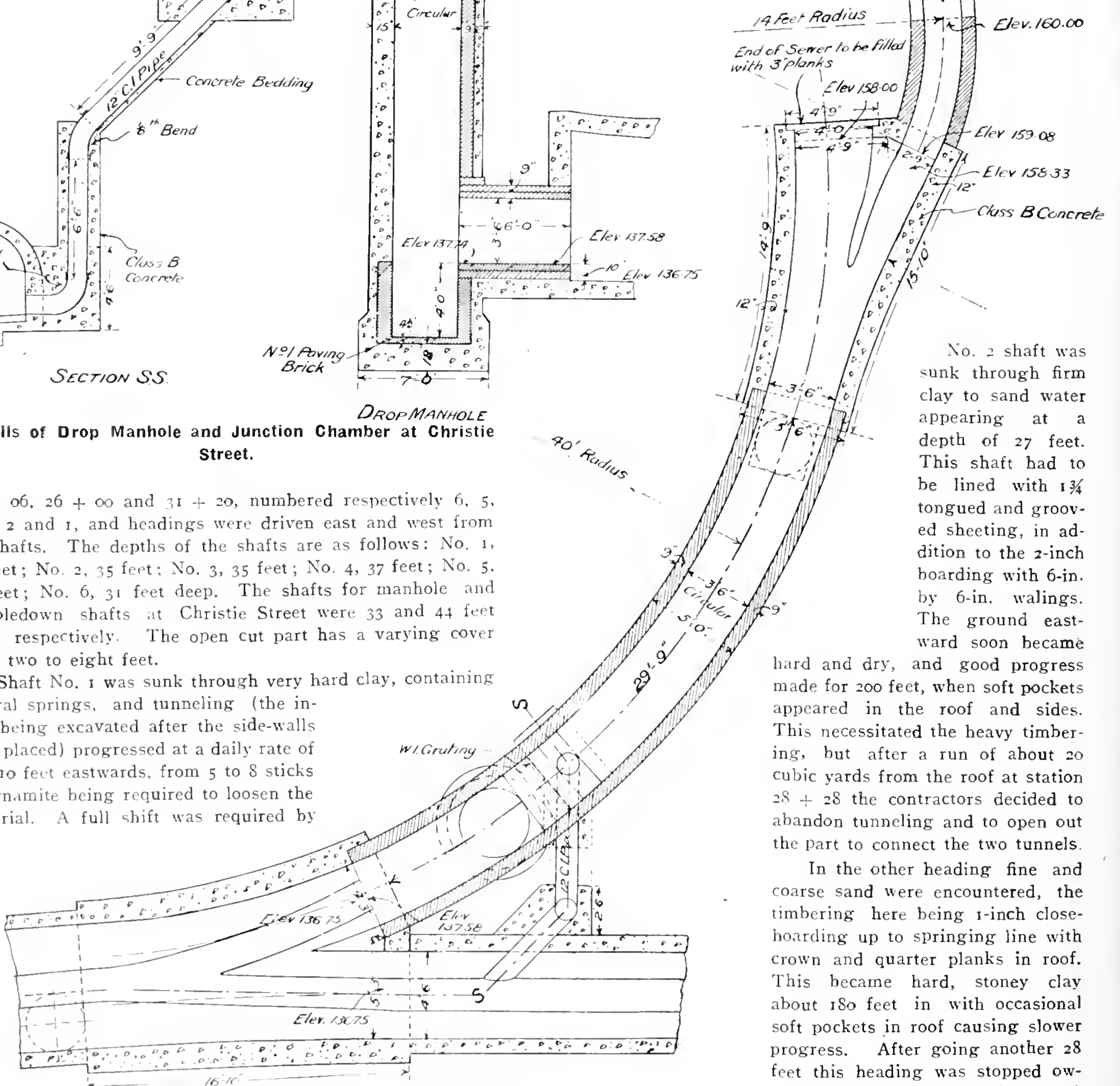
Shaft No. 1 was sunk through very hard clay, containing several springs, and tunneling (the invert being excavated after the side-walls were placed) progressed at a daily rate of 8 to 10 feet eastwards, from 5 to 8 sticks of dynamite being required to loosen the material. A full shift was required by two miners and one mucker—two muckers being required as the haul became longer.

In the other direction quicksand appeared in the bottom of the tunnel about 150 feet in, and rose above the crown a few feet further on. Water became troublesome at this point and the siphon in the shaft had to be replaced by a 4-inch pump.

The method of excavating was now altered, and with 6 x 6 cap and by timbering an advance of only four feet was made in a double shift. After several runs of semi-liquid pockets, extending almost to the surface, the heading was abandoned and bulkheaded at station 29 + 62.



Details of Drop Manhole and Junction Chamber at Christie Street.



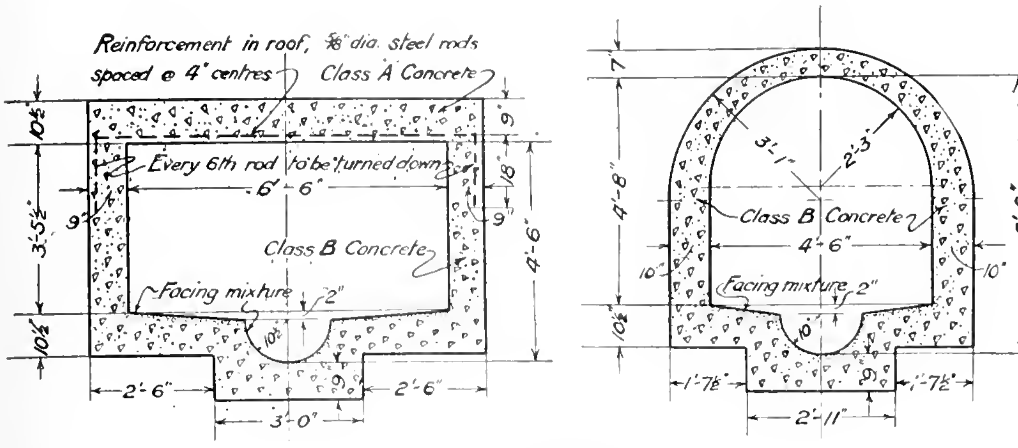
Junction Chamber at Christie Street.

No. 2 shaft was sunk through firm clay to sand water appearing at a depth of 27 feet. This shaft had to be lined with 1¾ tongued and grooved sheeting, in addition to the 2-inch boarding with 6-in. by 6-in. walings. The ground eastward soon became hard and dry, and good progress made for 200 feet, when soft pockets appeared in the roof and sides. This necessitated the heavy timbering, but after a run of about 20 cubic yards from the roof at station 28 + 28 the contractors decided to abandon tunneling and to open out the part to connect the two tunnels.

In the other heading fine and coarse sand were encountered, the timbering here being 1-inch close-boarding up to springing line with crown and quarter planks in roof. This became hard, stoney clay about 180 feet in with occasional soft pockets in roof causing slower progress. After going another 28 feet this heading was stopped owing to grade going with the tunnel

and the sub-drain not being able to carry off the water.

The most expensive shaft to sink was No. 3, quicksand being found 15 feet below the surface, requiring tongued and grooved sheeting, in addition to two inner sets, the ground becoming very hard clay two feet above the crown. To meet the tunnel from No. 2 shaft only 86 feet were necessary and only 14 feet were excavated westward before meeting



Typical Sections.

From Station 0 + 00 to 6 + 15. From Station 6 + 32 to 26 + 12.

from shaft No. 4, the soft pockets appearing in the roof, while up to springing line the clay was exceedingly hard, but was not blasted on account of disturbing the caps and lagging or causing a cave-in of the roof.

Progress from shafts 4, 5 and 6 was made at an average rate of 10 to 14 feet per shift in firm clay.

The shallow section in the park was completed during hot weather across the bed of the old Garrison Creek, water bearing sand being met with for 250 feet from the end. The invert was laid immediately after excavation, the walls then being built in the dry. At the foot of the slope (Sta. 5 + 40) tunneling was started to meet the one from shaft 6. The ground was dry sand and was timbered with cap and legging as far as the flat-topped section extended. This was left unlined until the headings met and were lined in order to have headroom.

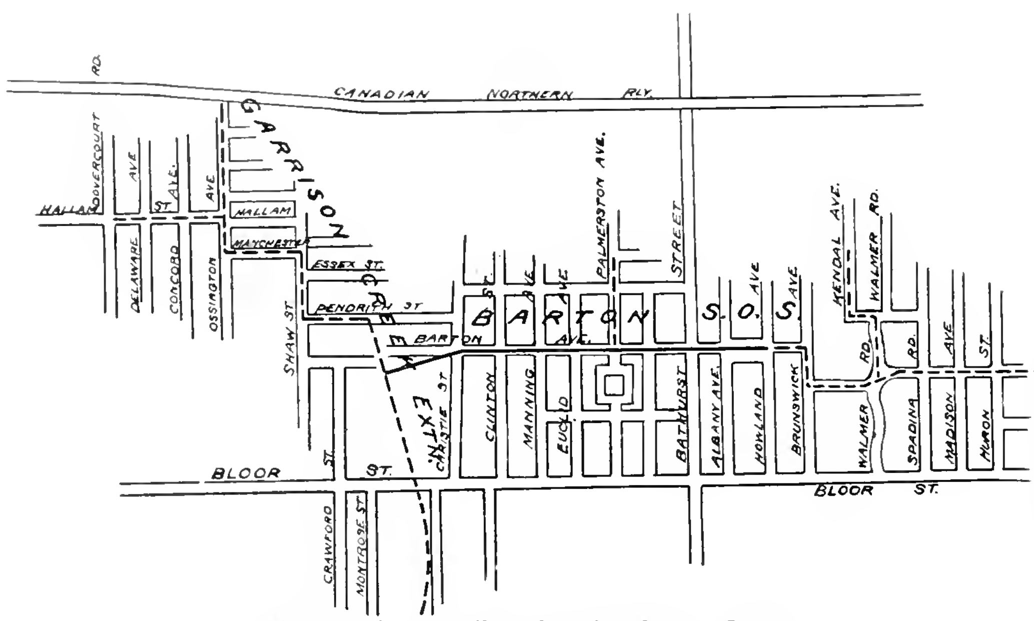
For about 300 feet the arch section only required crown and quarter planks in a 12-ft. length. At this point the ground became clayey with soft pockets in roof, and gave trouble for about 90 feet. In the portion between the abandoned headings the contractor sunk a shaft midway and essayed tunneling both ways. On finding quicksand at a height of 10 feet above the invert, they gave up the attempt, and opened 70 of the 134 feet to be done. Two sets of timbering and one set of tongued and grooved sheeting were required in excavating to sub-grade. The walls and arch were completed before excavating for invert. In the remaining 30 feet and 34 feet at the ends, the excavation was removed up to the hard ground and the roof lightly timbered. The timbering was braced from 12-in. by 12-in. needles, one end resting on the old concrete and the other on the more recent arch. After concreting the walls and arch, the sheeting was cut off at springing level and the voids at the back filled up. After the concrete had set the needles were removed, the roof being braced directly from the concrete until the back filling was done. Voids in the roof and settlements of backfilling were made good with sand through 12-inch auger holes bored from the surface.

The concrete lining was done each night by a gang supervised by two inspectors. The concrete was hand-mixed and sent down the chute directly into the tunnel cars.

The forms were originally 5-in. by 4-in. built-up lumber ribs with 2-in. by 2-in. dressed laggings. The ribs were set on footblocks and braced at the bottom from the rail ties. The lumber ribs were dispensed with after some time and replaced by 2-in. by 2-in. T iron ribs in one piece, and bent to conform to the arch. These gave 6 inches extra clearance for the cars and where not damaged by the blasting.

The laggings joined up badly and did not leave a good finish, which necessitated the surface being plastered.

In bad ground, where centre posts supported the roof, the posts were concreted round, the holes being filled up when posts were removed. The invert, with sub-channel, was laid in 12-foot lengths, the channel in the rough being formed by 2-in. by 2-in. laggings with half-round blocking pieces braced from the roof. The facing mixture was applied to the channel under drums placed in position as soon as the laggings were removed. At one or two places the wall became undermined while excavating for sub-channel in soft places owing to want of braces, and broke away from the arch. These breaks were repaired after invert was set.



Map Showing Location of Barton Avenue Sewer.

The Garrison Creek extension sewer is still undergoing completion, and to avoid cumbersome by-pass channels, the connections to the intercepted sewers had to be built so that the sewage could take up its old course until the new sewer was entirely in commission.

At Christie Street, the invert of the existing 2-in. by 3-in. egg-shaped sewer, 16 feet below the surface, is diverted into a new junction chamber, which provides a connection for an additional 4-ft. diameter sewer relieving the Christie Street drainage area. A flume at present carries the sewage over the diverted invert into the old sewer, which, when the flume is removed, will be closed by an iron stop plate working in iron grooves. An inspection manhole is built directly over this connection.

Abandoned Heading at Station 29 + 62.

A 3-ft. 6-in. diameter sewer leads from the junction chamber on a 40-ft. rod, curves to the tumbledown shaft, which is lined with vitrified brick. This shaft has a well 4 feet below emptying level, which flows directly into a chamber at tunnel level. The sanitary flow enters the tunnel as before described by a C.I. pipe. These were constructed as far as possible in the tunnel shafts.

The work was done under Mr. W. R. Worthington, assistant engineer for sewers by Messrs. Lehman, Graham and Jeron.

ZOELLY STEAM TURBINES.

Low steam velocity, as well as the simplicity of design, which are the main features of the Zoelly steam turbine (manufactured by Escher Wyss & Company and a number of licensees) have not only made this turbine type very economical regarding low steam consumption, but have also the effect that the high economy is maintained practically for any time of running.

Below we give the test results on two Zoelly turbines supplied by Escher Wyss & Company to the Dusseldorfer Rohren Industrie A. G., Germany. These turbines were installed in August, 1910, and have since been running continuously. The main data are as follows:—

Output .... 1,500 h.p.
Speed .... 3,000 r.p.m.
Gauge pressure .... 170 lbs. per sq. inch.
Superheat .... 662 deg. Fahr.
Vacuum .... 90 per cent.

Each turbine is fitted with surface condenser with rotary air and centrifugal cooling water pump, the cooling water being recooled in a cooling tower. After three months running the first tests were made (November 1st, 1910); after a further run of 13 months, each turbine being run for 4,000 hours and having generated 450,000 kw. hours, the second tests were made (December 27th, 1911); no inspection or cleaning was done before the test. The results of these two tests are tabulated below.

The second tests were made with the purpose of ascertaining to what extent the steam consumption had increased after one year's run. The results proved that no variation in the steam consumption had taken place, and when, after tests, the turbines were opened, no wear could be found on the nickel steel blading.

The steam consumption figures guaranteed by the manufacturers were easily obtained, and in fact the test figures were several per cent. lower than guaranteed. The last columns of the table below show that the figures obtained after three months' and after 16 months' running are practically equally good when compared with the respective guarantees. When taking into consideration that the vacuum at full load during the test was 92.1 per cent., and the superheat 580 deg. Fahr., the steam consumption of 15.15 lbs. per kilowatt hour is very good.

Test results on Zoelly turbine No. 2, installed at power station of the Dusseldorfer Rohren Industrie A. G., Dusseldorf, supplied by Escher Wyss & Company:

	Nov. 1st, 1910.			Dec. 29th, 1911.		
Duration of test, mins.	70	54	57	61	120	60
Rev. per min.	3000	3000	3000	3000	3054	3036
Output in kw., excluding excitation	277	541	781	1047	1044	547
Efficiency of generator, per cent.	73.6	84.6	88.9	91.0	91.0	84.6
Gauge pressure in front of stop-valve, lbs. per square inch	190	187	182	181.1	170.5	172.4
Superheat, deg. Fahr.	505	540	556	579	480	458
Vacuum in inches (barometer 29.2 in.)	27.94	27.68	27.3	26.9	26.78	27.54
Total steam consumption, lbs. per hour	5840	9620	12820	15880	17320	10510
Steam consumption per kw. hour	21.82	17.40	16.83	15.15	15.52	19.2
Correction for steam temperature (12½ = 1 per cent.) %	—12.4	—9.5	—8.0	—6.9	—14.14	—16.1
Correction for vacuum (1 per cent = 1.5 per cent.)	+3.2	+3.2	+3.2	+3.2	+2.5	+2.5
Total correction in per cent.	—9.2	—6.3	—4.8	—3.7	—11.9	—13.9
Steam consumption per kw. hour at 662 deg. F. and 26.3 in. vac. at full load	20.1	16.58	15.63	14.58	14.58	16.5
Guarantee of manufacturer (without margin)	20.6	17.5	15.74	14.97	14.97	17.06
Better than guarantee (%)	3.7	2.8	.7	2.6	2.6	2.8

An order-in-council has been passed amending the harbor regulations of Canada and prohibiting the discharge or disposal of oil, tar or other dangerously inflammable material in the water of any harbor of the Dominion. The order provides for a fine of $50 for violation of its provisions, with a further penalty of $10 for every twelve hours during which the offence continues.

THE ROAD QUESTION IN MANITOBA.*

By A. McGillivray.†

I have wondered several times if the municipal men who had charge of the construction and improvement of roads during the past year have looked back over the season's work, and could there see something that had been done during the past year which tended to give Manitoba some mileage of good roads; that is, if they could see something that had been done which might be counted as a permanent improvement towards the foundation of building up a system of roads for Manitoba. No doubt many of the municipal men will say that they have, that something has been done; others may be a little doubtful of the matter; but, for myself, when I looked back over the season's work, I cannot say that a great deal has been done towards giving Manitoba a system of good roads. I cannot say that there has been any great construction of mileage, but I will say that a great step has been taken by securing good legislation in this connection. At the last session of the Legislature, legislation was secured by the efforts no doubt of this Association of Rural Municipalities towards this end, and, as you all know, there are at present on the statutes of the Province two Acts which were placed there at the last session. One is known as the Good Roads' Act, which this Convention, in conjunction with the Manitoba Good Roads' Association, has been instrumental in putting into force That Act, as it appears on the statutes to-day is, in my opinion, a workable Act, and one quite applicable to the conditions that exist in the municipalities of this Province. From the amount of correspondence that I have had during the summer from municipal men in regard to these Acts, I believe that there has been, and is still, some confusion and confliction as to the intent and meaning of both these Acts, and in that event I would just like to take a little of your time in explaining the Acts as I interpret them, or as I believe they are intended to be interpreted. The Good Roads' Act, which was put on the statutes last session with the recommendation of this Convention, provides for the improvement of municipal roads, that is, roads in the municipality that will benefit all the municipality as a whole, and not pertain to any special or particular part of the municipality. The idea was to get the municipalities to undertake a system whereby they could start some plan to improve a certain mileage of roads. While it naturally follows that these roads should be the main roads of that municipality—(roads leading from the towns and market places and villages into the country districts, allowing the farmer to haul his grain to and fro, and putting them within reasonable distance of all ratepayers), it is apparent to everybody that such roads could not be constructed to every man's door, but the intentions and the objects should be to construct these roads so as to place them as near as possible, in order that they will benefit the municipality as a whole to the greatest extent.

Now, under that Act the Government provides for the guaranteeing of the bonds of the municipality; that is, if a scheme is drawn up and presented to the Department of Public Works undertaking a plan such as I have mentioned that is and will be a benefit to the whole municipality, then the provisions of the Act provide that of a municipality raises sufficient debentures to cover the cost of the work, the Government will guarantee the bonds, insuring a probably cheaper rate of interest, and also extending the terms of those bonds over a longer period of years than is prescribed in the Municipal Act. The extent of the bond to be raised is 3 per cent. of the total assessed valuation of the municipality. As I said before, the Act is workable and very applicable to the conditions of this Province, and I believe that if the municipalities of this Province would consider that and take it up, a step would be made in the right direction towards securing better roads.

The Highway Improvement Act, which is another Act which has been placed on the statutes, was put there for probably a different purpose, and it is the confliction of these two Acts, I believe, that has caused a great deal of the confusion in the minds of some of the men of the Province. The Highways Improvement Act was intended to construct provincial roads, or a provincial road—that is, to connect the larger centres of population of this Province. For instance, a road from Winnipeg to Portage and Brandon and to the western portion of the Province. Then another might be considered running from Winnipeg to Emerson. The idea was to get the larger centres of population to endeavor to induce the municipalities of this Province to construct a higher class of road than it would probably be necessary for them to construct in the municipal system. The idea is prevalent all over the Dominion of constructing provincial roads. We hear a good deal of a transcontinental road—that is, a road connecting all the Provinces from ocean to ocean. But, aside from that, in the different Provinces at the present time there is an idea to construct these roads and join up the centres of population, the larger towns of the different Provinces, and to build a road of a higher standard than would be necessary in a municipality itself, and probably the municipality would be able to construct another municipal system of their own, which would be taken care of under the Good Roads' Act.

I have no doubt that many of the applications which have come in for municipalities to be placed under this Highway Improvement Act have been done probably from a desire, no doubt, to participate in the Government grant, and the desire, of course, to build up the roads in their several municipalities, and no doubt some disappointment has been met by some of the municipalities in not knowing the true meaning and intent of the Act, and probably being refused to be allowed to come under this Act at the present time. But, Mr. President and gentlemen, in connection with this Act, as I said before, the Good Roads' Act in my opinion is a good Act, good in name as well as in terms, and should be taken up by the different municipalities with the Provincial Government. There are a few recommendations that I have been making to the Government of the Province in regard to both these Acts, which I have the privilege to submit to you this morning, and would ask you to consider them and find out what they are worth. There may be probably other changes that would appear to you to make these Acts more applicable to the conditions here in the Province, but there are a few that I thought would be necessary to the proper working out of the Act, and, as I said before, I have laid them before the Government, and have their permission to lay them before you for your consideration.

In regard to the Good Roads' Act which, as you know, is the Act by which the Government guarantees debentures for the main roads of the municipalities, independent of any provincial scheme or idea that may be in mind, this was passed at the last session of the Legislature. In my mind, it fills all the requirements to insure construction, except that no Government aid is provided, which to a very considerable extent is responsible for its provisions not being more largely availed of by the municipalities. I would suggest amendments as follows: (1) Provision enabling the Government to contribute towards the cost of any work performed under the Act to the extent of, say, 25 per cent. It is for the municipalities to consider whether that is enough or too much. It may be too much; in my mind it is the maximum. In making this suggestion I have given the maximum, and I

*Address delivered before Ninth Annual Convention of Union of Manitoba Municipalities, Winnipeg, Man., Nov. 26—28, 1912.

†Highway Commissioner for the Province of Manitoba.

would further recommend that this sum be provided by Parliament yearly to meet the expenditures for the ensuing year. Secondly: Provision that any work performed and aided under this Act shall be maintained and kept in good repair by interested municipalities to the extent and manner satisfactory to the Highway Commissioner failing which such repairs may be performed by that official and paid for and levied by the Municipal Commissioner against the respective municipalities in default.

There is a word I would like to say on the maintenance question before I go any further. Is there any use of us thinking of building roads in this Province and leaving them to deteriorate from lack of maintenance, we might as well not build them at all. A good road that is built and laid down in this Province requires certain attention to keep it up to the standard at which it was put down. If we neglect to do that we are working a hardship on the taxpayers of this country, because if we build roads by money that is borrowed on terms extending over a long period, say, for twenty-five or thirty years, the burden would fall on the people who are coming afterwards in later years, and who must assume their portion of that taxation; we must give them something for their money. What I mean by maintenance is this: that a grade should not be allowed to deteriorate and disappear, as grades certainly will do if not looked after very carefully. The great percentage of our roads in this Province are earth roads and no matter how well you build the roads to grade or dig the ditches, if you have not proper drainage, if you allow the ditch to become silted up or become defective and left without any care at all, as many of our ditches have been in the past, in five years they will be useless. I know ditches that have been built fifteen or twenty years ago that have been allowed to deteriorate, and to-day they are only a mark in the ground. So it would be wrong, in my opinion, for the municipalities of the Province to borrow money at long terms and to perform work and let it go to rack and ruin. That is what I mean by proper maintenance; preventing the work from deteriorating.

In regard to the suggestion toward the Highway Improvement Act. This Act, I believe, is a commendable one also. We should have in this Province a mileage of roads of a better class than earth roads, if it is possible to at all get them. Other Provinces are striving to get them. We can't get away from the fact the automobile is the mode of locomotion that is going to stay. People are taking to the automobile. There is no better way in which the value of the farm can be observed than in travelling along a good road, and there is no way in which the development and worth of a country can be more lost sight of than in travelling over a bad road. I believe it is up to the old established municipalities to bring into existence what might be called a few provincial roads of gravel or macadam in the not too distant future. It was for this end that this Act was placed on the statutes. The Government are anxious to see this done, and they are willing to contribute largely, so largely, indeed, as to leave themselves open to extend that assistance to two-thirds of the actual cost.

I would suggest under the Highways' Improvement Act, in order to avoid confusion with the provisions of the Good Roads' Act, that it be determined by legislation to what leading highways in the Province, describing the routes, it is intended that the Act should apply, and shall be constructed and aided under it; with the further provision that the Lieutenant-Governor-in-Council shall have power to add to the number of roads from time to time.

I believe that the Government should indicate where they want the municipalities to take up this work, because the Government would not and do not intend to build those provincial roads themselves. They want the co-operation of the municipalities through which those roads are to pass. The Government could advance a plan to certain municipalities of this Province that they would be first in line for this road. It would be then up to them either to come forward and accept their proposition or reject it. We cannot build these highways through every municipality in the Province; it would be out of the question for the country to do so but if the government would come forward and say where they intend these roads should be, the municipalities through which they are going to pass would be in a better position to take up the work. I believe it would be a valuable provision of the Act.

Further, I would suggest that an amendment should be made so as to permit a municipality to assess its portion of the cost of works performed under the provisions of the Act partially over the lands abutting on both sides of said highway or highways. Because, however anxious a municipality might be to participate in the provisions of this Act, they might be defeated in such a project by having to submit a by-law to the whole municipality, whereby they would raise a portion of the cost of the work over that whole municipality. I believe a road of that nature running through any municipality would be a certain benefit to the whole municipality, but it would particularly benefit the land immediately adjoining the road, and I believe that the land that is particularly benefited should be particularly assessed to pay for it.

HEAVY RAILROAD CONSTRUCTION.

By Sir Thomas Shaughnessy, C.V.O.

Notwithstanding the large amount of railway construction in Canada during the past year, there is every indication that quite as much will be required during the coming year. This means a great deal for the country because, besides giving employment to many thousands of men in the making of the railways, it naturally stimulates manufacturing in the rail mill, iron and steel works, lumber mills and a large number of other establishments, and keeps the wheel of national prosperity spinning.

Speaking for our own company, the rail requirements for the next year will approximate 250,000 tons, and these, with the requisite fastenings, will represent an expenditure of over $8,000,000.

During the past year, in addition to keeping our own manufacturing shops occupied to their capacity, we have taken all the cars and locomotives that we could have built in Canada, and have also made large contracts with manufacturers in the United States. At the present time our outstanding orders for cars and locomotives, to be delivered before the end of 1913, aggregate $30,000,000, and a very large proportion of this amount will be spent in Canada.

Then there are the other works, to which reference was made in the annual report. The extension of our double track system East and West, the important terminal works at Montreal, Toronto, Winnipeg and Vancouver, and the large locomotive and car works at Ogden, near Calgary, that will involve the employment of very many men, and the use of a great deal of material.

We fully recognize the transportation necessities and claims of the country and it is our anxious desire to meet them in so far as the obligation rests with our company, but our operations are frequently delayed by conditions that we cannot overcome, such as an unfavorable season and a shortage of men and material.

My own feeling is that, surveying the situation conservatively, the year 1913 will be replete with development, progress and prosperity for Canada.

INSTALLATION OF ROTARY CONVERTERS AT C. P. R. DOCKS, FORT WILLIAM.

The following installation of two 600-kw. Westinghouse rotary converters with necessary accessory equipment of transformers, equalizing generator, etc., was made during the past summer for use by the Canadian Pacific Railway at their new coal handling docks, Fort William.

Power is received at 25,000 volts from a 3-phase, 60-cycle line and transformed through two sets of three 200-kw. single phase transformers, oil-insulated, water-cooled, 60-cycle star connected primary 14,500 volts, delta connected secondary 178 volts.

At the latter voltage it is delivered to the two 600-kw., 6-phase rotary converters shown in Fig. 1. These machines give 250/280 volt D.C. 2,400 amp. at 600 r.p.m., and are connected in parallel to the D.C. bus bars.

As the load is a rapidly fluctuating one, special provision had to be made to handle the peak loads. This has been very successfully taken care of by the use of a fly-wheel direct connected to a D.C. machine which alternately operates as a generator or motor across the D.C. bus bars. This is perhaps the first application of this system to the unloading of coal.

The D.C. equalizing machine is rated at 400 kw., 250 volts compound wound, and is capable of handling heavy overloads for short periods. The direct connected fly-wheel weighs 15 tons, made up of solid steel plates which gives a high factor of safety and is enclosed by heavy steel plate cover. This machine has a speed variation of from 450 to 600 r.p.m., depending on what load is being taken from the D.C. bus bars.

On light load the set automatically speeds up, taking power from the line, but with a heavy load on the line the speed tends to fall off and the generator feeds back on the line taking power from the fly-wheel. This speed variation is obtained by changing the shunt field resistance through a water rheostat, which is operated by a special torque motor.

Lightning protection is afforded by air-cooled choke coils and a three-phase type "A" electrolytic lightning arrester designed in this case for use on a 25,000-volt line. In Fig. 2 the arrester tanks are shown mounted in the gallery. This picture also gives a good idea of the open nature of the high-tension bus bar arrangement. The bus bars are connected to the incoming line and to the transformers through type "E" 35,000-volt, three-pole, hand-operated, automatic, oil circuit breakers.

Besides the transformers supplying power to the converters there are two 3-phase transformers for A.C. power purposes. They are rated at 100 kw. and transform from 25,000-volt primary to 2,200-volt secondary.

The switchboards are of black marine finished slate, mounted on angle iron frame. A total of 17 panels has been installed. The control panel for the incoming line is shown in Fig. 2 in front of the transformers, while on either side of it are the panels controlling the A.C. side of the rotary converters.

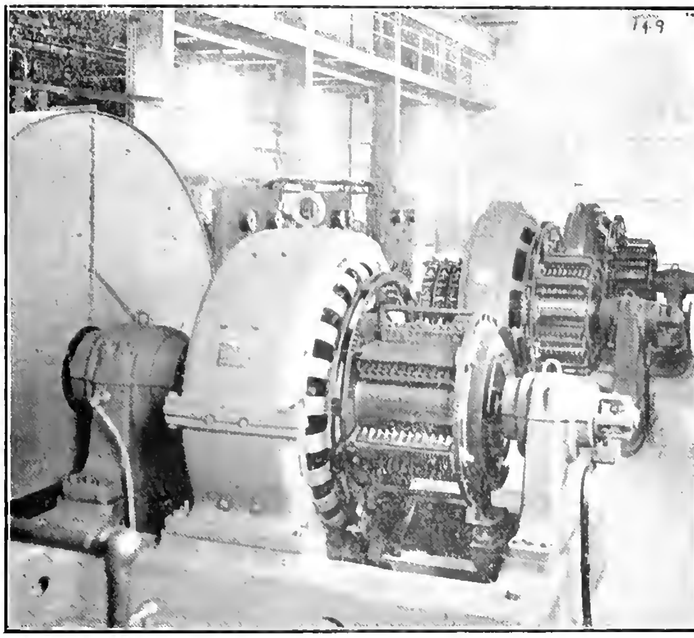


Fig. 1.

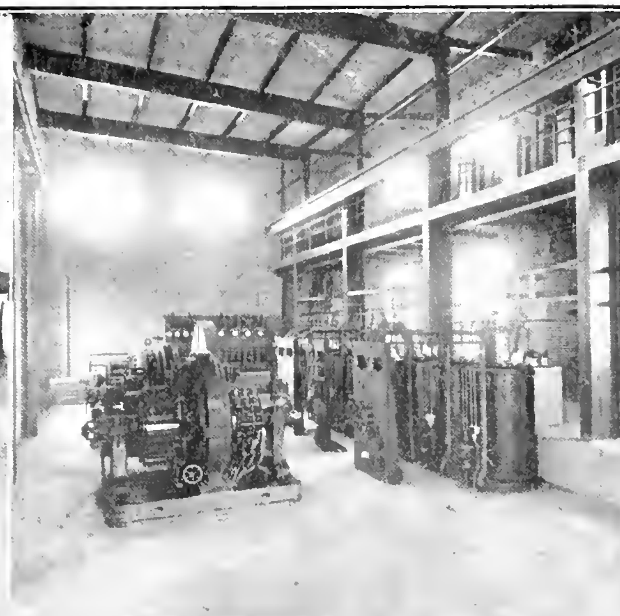


Fig. 2.

Mr. R. S. Kelsch was consulting engineer and the equipment was manufactured by the Canadian Westinghouse Company at their Hamilton works.

WATERPROOFING AND ACIDPROOFING CONCRETE FLOORS.

Where water is coming through concrete because of porosity, the Aberthaw Construction Company, of Boston, have found that a treatment of boiled linseed oil thinned down with gasoline will do much to cure the trouble. They have built roofs which were to cover delicate instruments in fortification range finders. These roofs proved porous, but a treatment with boiled linseed and gasoline cured the trouble permanently. It is a thoroughly good treatment for porous brick walls, has the merit of being very cheap, and the materials are reasonably available, and the most ordinary laborer can apply it intelligently enough. Besides this method, paraffine can be dissolved in gasoline and applied in a similar way with good results.

There is probably nothing that can be done to make a cement floor acid-proof. The treatment with linseed oil will retard the effect of acid, and of course particularly dense concrete will deteriorate more slowly than porous concrete. Where acid is to be used it is economical to give the floors several good coats of linseed oil and gasoline, and if possible during shut-downs to repeat them.

SOLVING CANADA'S TRANSPORTATION PROBLEM.

By J. L. Englehart.

The progress and development of Canadian railways has been marvellous. In 1835 there was not a mile of railway in the Dominion, there were only 16 miles in 1845. Ten years later, 1855, this had been increased to 877 miles. In 1865 there were 2,240 miles. While forty years later, 1875, there were only 4,804 miles in the whole Dominion.

The year 1885 was that in which the Canadian Pacific Railway completed the initial portion of that monumental labor, the Canadian Pacific Railway, and the mileage mounted to 10,733 miles. In 1895 the total was 15,977 miles, which in 1905 had increased to 20,487 miles, and in 1910 to 24,831 miles, while in 1911 no less than 25,400 miles of railway were completed and operated.

In addition to this there were many miles in the hands of contractors, being graded, and laid, or being laid.

Add to this 1,610 miles for double track, 5,550 miles of yard tracks and sidings, and a total of 44,193 miles of railway completed and under construction is obtained. Surely this is a record of which even our own grand Dominion has a just right to be proud.

The earnings of the railways were as follows:—

Year.	Earnings.	Expenses.	Per cent.
1905	$106,467,198	$ 79,977,573	75.2
1911	188,733,494	131,033,785	69.4

The capitalization amounted to the following amount, which is so large as to be hardly understandable:—

Stocks	$ 749,207,687
Funded debt	779,481,514
Total	$1,528,689,201

	Passengers carried.	Freight tonnage carried.
1909	32,683,309	66,842,258
1911	37,097,718	79,884,282

The following amounts were paid to employees of railways for labor:—

	1911.
Maintenance of way and structures.....	$18,157,696
Maintenance of equipment	15,544,057
Traffic expenses	1,564,399
Transportation expenses	36,832,034
General expenses	2,515,552
Total	$74,613,738

In 1909 the total was $63,216,662, and the ratio of gross earnings and operating expenses of total wages is shown below:—

	1910. Per cent.	1911. Per cent.
Ratio of gross earnings.........	38.61	39.53
Ratio of gross expenses.........	55.8	56.9

and is still mounting upwards.

The number of employees operating railways is 141,224—not including construction work.

Are the developments of the Dominion, and this construction of railways, are the efforts put forth, the efforts of the past ten years, to continue? If so, then we are justified in asking for co-operation.

Transportation is largely the question of the to-day of the to-morrow. Statistics show that railways have been practically re-built, rails, engines, rolling stock, ties per mile, telegraph and telephone, augmented to an extent that is hardly understood by even those who are interested in the matter. Stations, terminals, sidings, and buildings being enlarged, rails increased in weight, with these the other manifold demands that are made upon transportation companies of the day, call for largely increased capital expenditure; in very many instances, an addition of half, if not doubling the original capital.

Have tariff rates, passenger and freight, been increased? The answer is no.

Co-operation is permitted in trades, in labor, in every line. That is right, as it is equitable, for the reason, if none other, that it largely replaces wastefulness engendered by unfair competition, which has spelt ruin to so many enterprises.

In the present-day rush much of this has been forgotten by capital, labor, producer, consumer, manufacturer and the farmer. Each and every one has been enabled to improve their position, as well as the surrounding conditions. Then why not enlist, and work for the common weal, or accept the common woe, that transportation is sure to fall into, unless better counsels prevail?

Why cry out against the good work that has been, is being done by those who labor, and it is a labor, a ceaseless labor, of those who are in charge of transportation?

Consider what it would mean to you, to every one, in the face of the statistics that have been noted, if the problem of transportation were to be dealt with upon the narrow lines that appear to appeal to many. Instead of playing the game of clamor, why not aid and assist in improving the conditions?

Every transportation official knows there are shortcomings, every official is alive, as never before, to bettering the conditions. With passenger rates to-day averaging per passenger per mile, 1.94c., less than two cents per passenger per mile. With freight rates averaging per ton per mile 7.77 mills, less than eight-tenths of one cent for moving a ton (2,000 pounds) one mile.

Under these conditions, how are transportation companies to exist, if they cannot meet expenditures by receipts?

Transportation to-day means facilities that were not in vogue in days that are gone, rolling stock of every class and kind, engines of abnormal power, to which must be added the hundred and one requirements to-day demanded, which were not thought of in the past.

Transportation can be materially assisted by good roads, by diagonal roads. Expend millions, yes millions, upon diagonal roads. With sufficient good roads, you will largely solve that all-important question, transportation.

The motor vehicle of to-day is as essential to the farmer, the merchant, as to the reaper, the mower, or the thresher. The use of the motor would materially assist in arresting congestion. Many merchants to-day utilize motors for deliveries, saving dollars and cents.

The delivering of merchandise direct to the merchant or consumer by motor cars means a saving all round. With good roads, producers, farmers, manufacturers, can deliver less than carload lots, as well as carloads to central points, where the less than carloads could be transferred into carloads, transported with less transhipment, without breaking bulk and without transfer from one car to another. The motor car would largely serve the necessity, arresting congestion, if not removing it entirely.

That is the problem, to handle the many cars. That is the question that worries transportation men. Transportation companies have enlarged—are enlarging—every possible facility—terminals, sidings, motive power—but it is becoming a physical impossibility to transport the products of to-day within the time expected.

No more can shipments in less than carload lots nor for that matter in carload lots be delivered to the markets, in

the time that shippers demand. Neither power, rolling stock, terminal facilities, or tracks are adequate to meet such conditions. But with good diagonal roads, with motor cars, a revolution in transportation will be affected, largely decreasing less than carload shipments, lowering rates of freight, improving the facilities of transportation, removing, largely, the necessity of railways furnishing their cars for warehousing purposes, either to shipper, or merchant, who delay their orders for supplies until about the last day, if not hour, then clamor for delivery, while their own shortsightedness, their own pockets have all but forced the railways into a state of congestion.

Notwithstanding the largely increased number of miles of sidings, and terminals, enlarged warehousing facilities, extra trains, heavier engines, larger cars, congestion is a burning question and will be until the merchant, the shipper, the farmer, the producer, as well as the consumer, in fact till every one pulls his pound not for personal requirements but for the general good.

CONDENSATION UNDER CONCRETE ROOFS.

During the last year there has been considerable discussion in regard to the prevention of condensation under concrete roofs and it is, therefore, interesting to note the remarks in this connection of Leonard C. Wason, president of the Aberthaw Construction Company, of Boston. Mr. Wason states that under concrete roof, if the air is moist and hot, as it is in the principal part of a paper mill when the weather is cold outside, provision must be made to prevent condensation. Even with the best provision it is necessary in some places to provide for adequate ventilation, as dripping will occur whenever the air reaches the dewpoint. A thick concrete slab requires some insulation, even under only moderately bad conditions of dampness inside the building. Some of the roofing companies provide roofing felt, which goes on under the regular waterproofing of the roof surfaces. The disadvantages of this felt come from the fact that it is soft, and walking on the roof or particularly moving any heavy weight about on it will cut the roofing very readily. There is also the question of the permanence of the materials used in the felt. The cheapest and one of the most efficient methods of insulation that Mr. Wason knows of is to use on top of the roof slab a filling of porous concrete made up of screened cinders and cement. W. H. Ham, of the engineering office of French & Hubbard, of Boston, specifies as follows for such filling. His object is to get as spongy, porous material as possible and one that will have some cohesion, enough so that the roofing felt can be mopped down onto it, with the hope of its setting in position.

"**Cinder Fill.**—Concrete roofs shall be covered with a cinder concrete fill of thickness as shown. This fill to form crickets and other grades as indicated, minimum thickness, however, to be not less than three inches.

"Concrete for this work shall be mixed with one part by volume of Portland cement, fulfilling specifications required for other portions of the building work, and not more than ten parts by volume of clean, steam boiler cinders.

"The fill shall be placed as carefully as possible, so as to be left porous. After the fill has set up sufficiently to work over, the top surface shall be trowelled over with a flat coat of mortar to give a proper surface for the tar and gravel or other rolling material."

Difficulty develops with roofs on which furnace slag has been used and covered with an inch or more of sand finish, as the finish has expanded in the heat of the summer and has cooked up in big blisters.

BUILDING PERMITS

The following table, showing the value of building permits issued in 1912, compared with 1911, has been compiled from returns supplied to The Monetary Times by the various cities and towns direct:—

City.	1911.	1912.	Increase.	Increase per cent.
Berlin	$ 358,095	$ 842,613	$ 484,518	132.5
Brandon	1,024,529	1,166,214	141,685	13.7
Brantford	613,860	1,167,105	553,245	90.2
Calgary	12,907,638	20,394,220	7,486,582	58.0
Chatham	355,147	201,591	153,556(5)	43.1
Edmonton	3,660,327	14,446,819	10,786,492	294.7
Fort William	3,077,860	4,211,285	1,133,425	36.8
Galt	282,334	506,130	223,796	79.0
Halifax	508,796	579,775	70,979	13.7
Hamilton	4,255,730	5,491,800	1,236,070	29.0
Kamloops	530,860	559,703	28,847	5.4
Kingston	314,569	645,774	331,205	105.4
Lethbridge	1,033,380	1,358,250	324,870	31.3
London	1,036,880	1,136,108	99,228	9.5
Macleod	96,400	220,500	124,100	128.7
Maisonneuve	1,195,120	2,685,828	1,490,708	124.8
Medicine Hat	743,272	2,836,239	2,092,967	281.5
Montreal	14,579,952	19,641,955	5,062,003	34.7
Moose Jaw	2,475,736	5,275,797	2,800,061	113.1
Nanaimo	159,461	321,422	161,961	101.2
Nelson	167,000	275,000	108,000	64.6
New Westminster	1,124,587	1,634,528	509,941	45.2
North Battleford	240,080	896,970	656,890	273.3
*North Bay	157,406	462,675	305,269	194.2
Ottawa	2,997,610	3,621,850	624,240	20.8
Peterborough	345,372	465,905	120,533	34.7
(4) Point Grey	....	1,755,115	....	....
Port Arthur	595,180	2,494,179	1,898,999	318.9
Preston	244,375	337,160	92,785	37.7
Prince Albert	921,595	2,006,925	1,085,330	117.7
Prince Rupert	265,771	316,717	50,946	19.1
Red Deer	237,220	387,640	150,420	63.2
Regina	5,099,348	8,047,309	2,947,961	57.7
St. Catharines	265,435	811,335	545,900	205.6
St. John	572,700	647,200	74,500	13.0
Saskatoon	5,004,326	7,640,530	2,636,204	50.6
(3) South Vancouver	2,500,000	2,600,000	100,000	4.0
Stratford	103,500	367,233	263,733	255.3
Sydney	495,642	656,111	160,469	32.3
Toronto	24,374,539	27,401,761	3,027,222	12.4
Vancouver	17,652,642	19,428,432	1,775,790	10.0
Vernon	202,982	446,142	243,160	120.2
Victoria	4,260,315	8,208,155	3,947,840	92.4
Welland	342,808	469,744	126,936	33.9
(2) Weyburn	....	766,760	....	....
Windsor	739,595	1,098,063	358,468	48.4
Winnipeg	17,716,750	20,475,350	2,758,600	15.5

*Value of permits from May 17th to December 31st, 1911. No record kept previously.

(2) Figures for 9 months—building permit by-law brought into force in April, 1912.

(3) Estimated—no record kept previously to November 23rd, 1911.

(4) From May 13th to December 31st. No record kept previously to May, 1912.

(5) Decrease.

The value of the permits of 44 cities in 1911 was $135,000,000, and of 46 cities last year $196,000,000, an increase of $61,000,000.

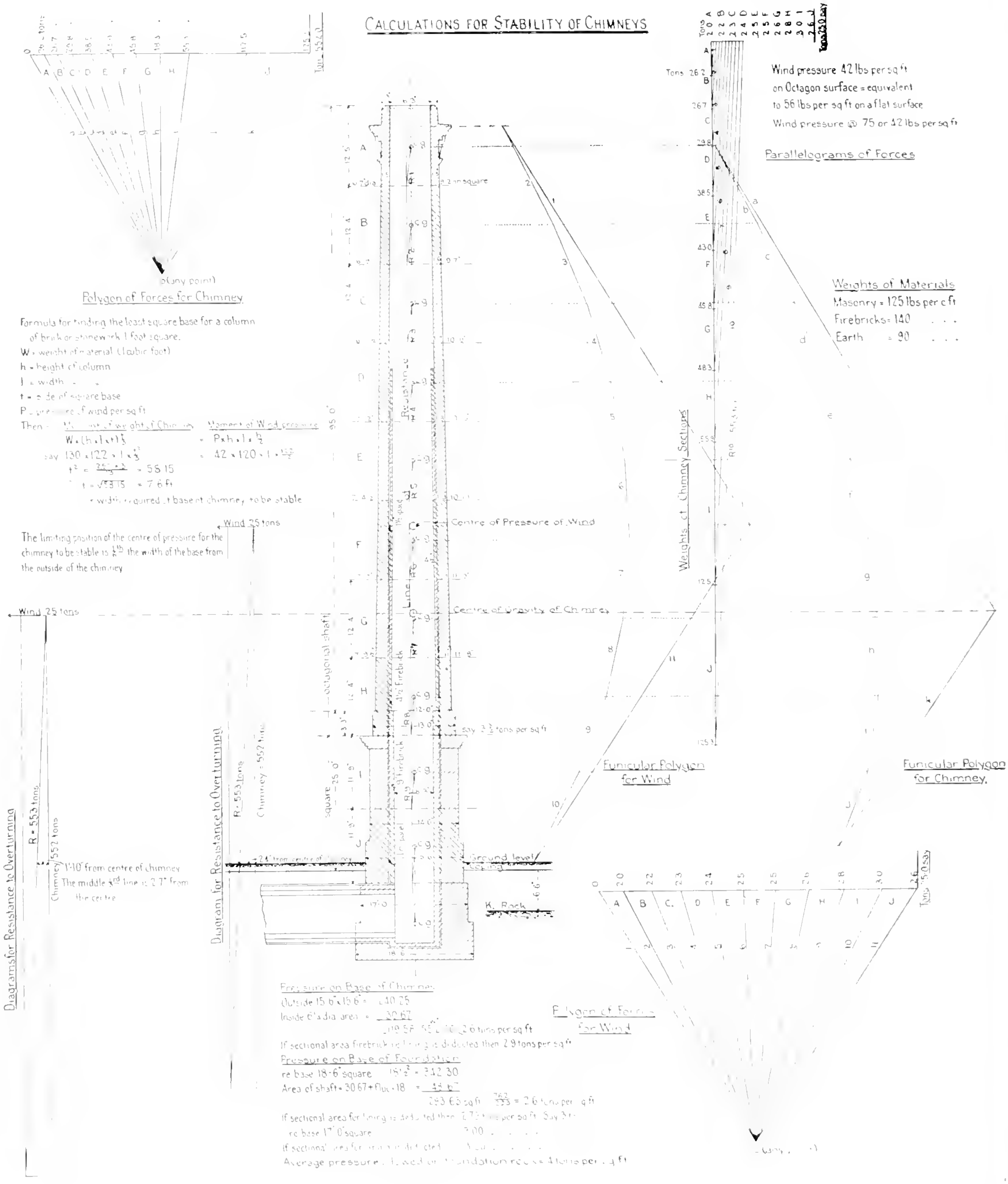
CALCULATIONS FOR STABILITY OF CHIMNEYS.

By Leonard Goodday, C.E. and M.E., late of the British Admiralty.

Calculations for the stability of chimneys are from time to time given, but as a rule simply for the turning point at the base, and level with the ground, and this is not sufficient of itself, when it is so essential to have it perfectly safe in every way, especially when the chimney is high; such, for instance, as one for a factory or engine house.

The one which it is proposed to illustrate fully is one for an engine house which was carried out some years back in the east, and which I will now explain step by step in detail

To commence the design, determine the height of the stack necessary for the draught, etc., and by moments, as shown to the left, find the required base t which, in this case,



is 7.6 ft. for a column of brick or stonework 1 ft. square to be stable. As the wind may come from any quarter, the base, when constructed, must be at least 7.6 x 2 square, i.e., 15.2 ft. x 15.2 ft. Of course, the greater the weight of stack, the safer the structure, and the sectional area of base will be, comparatively speaking, very little more than this for the same height.

This chimney is octagon in section, and the assumed pressure of wind 56 lbs. per square ft. on a flat surface; and the average pressure in this case becomes .75 of 56 lbs., or 42 lbs. per square foot, as given in sketch.

The chimney which is found necessary to be 120 ft. in height from the ground may now be designed in the usual proportion, and for the facility of calculation divided in equal sections of, say, 12 ft. 4 in., each section being lettered A, B, C, etc., as shown.

The next step is to find the pressure of wind at 42 lbs. per square foot on each of the above sections, the total result of which is found to be 25 tons, as shown on the right hand of diagram.

Next, by parallelograms of forces, find graphically their resultants in the following way: Draw the vertical line to scale representing the weight of section A, viz., 26.2 tons, and the horizontal force of wind, viz., 2.0 tons, and draw in the line R 1, which gives the resultant force for that section. Produce the vertical line representing A until it equals A plus B, then with the combined weights of the two sections A and B, viz., 26.2 plus 26.7 tons, and with the wind pressure, viz., 2.0 and 2.2 tons on the two sections A and B respectively, draw the resultant force R 2 and continue in this way until the total resultant force R 10, viz., 553 tons, is obtained at the base of section J.

It will be noticed that the lettering of the sections A, B, C, etc., of the chimney, with their weights, are shown on the left side of the parallelograms of forces, so that mistakes will be avoided.

Now put in the centre of gravity of each section, and draw in the lines R 1, R 2, etc., from the centre of gravity of A, B, C, etc., to the bottom of each section respectively, and parallel to R 1, R 2, etc., shown on the parallelogram of forces, and connecting these points by a line which is the line of resistance, and well within the middle third of each section.

The result of this investigation shows graphically that if this chimney were built up in sections placed one upon the other, only with their bases horizontal, and without being bonded together, there would be no danger of it being "crippled."

The next step is to determine the resistance to overturning of the whole chimney, first, when the centre of pressure of the wind is taken, and secondly, when the total pressure is taken at the centre of gravity of the chimney. It will be necessary to first find these points, the method of which is as follows:—

For the centre of pressure of wind: Draw the horizontal line, as shown, to the right, representing the pressures on the sections A, B, C, etc., by the pressures of each, viz., 2.0, 2.2 tons, etc., making a total of 25 tons. Take any point O, and connect the lines representing the pressures to this point, as shown by the numbers 1, 2, 3, etc. This figure represents the polygon of forces for wind, the letters A, B, C, etc., being the sections of chimney opposite each line of pressure respectively.

Next draw in the horizontal dotted lines from the centre of gravity of the sections A, B, C, etc., and also the line shown where the wind is assumed to commence to take effect.

Now draw the lines 1 and 2 from this last line parallel to the lines 1 and 2 on the polygon, the line 2 being drawn until it cuts the horizontal line from the centre of gravity of section B. From this point of intersection draw the line 3 parallel to line 3 on the polygon, until it cuts the horizontal line from the centre gravity of section C, and continue in the same way until line 10 is drawn, letting it cut the ground level. From this point of intersection draw line 11 parallel to line 11 on the polygon until it cuts line 1 produced. From this point draw a horizontal line until it cuts the chimney, and which is the centre of pressure of the wind. The figure just completed is called the Funicular polygon for wind.

In the same way the polygon of forces for the chimney may now be constructed as shown to the left, and from this can be obtained in the same way, the funicular polygon and centre of gravity for the chimney, the only difference being that this last polygon is commenced from the line from the centre of gravity section A, and finished from the line from the centre of gravity of section J.

On the line for the centre of pressure of wind draw a line representing 25 tons total wind pressure, and a vertical one representing 552 tons the dead weight and centre line of chimney, and complete the resolution of forces. The resultant R works out to 553 tons, and is the resistance to the overturning at ground level. This line is found to be 2 ft. 4 in. from the centre of chimney.

In a similar way construct another diagram, but from the line for the centre of gravity of chimney. The resultant R or line of resistance is found to be 1 ft. 10 in. from the centre of the chimney.

Now, the chimney at ground level is 15 ft. 6 in. square, and consequently its middle third is 5 ft. 2 in. or 2 ft. 7 in. on either side of the centre, and as the two resistances to overturning are 2 ft. 4 in. and 1 ft. 10 in. respectively, the chimney is perfectly safe.

The last and equally important step is for the foundation which should be made perfectly solid and of concrete, the strength of which should be according to the total pressure, including everything, on the base of the foundation.

The trial sectional area was taken at 21 ft. 6 in. square, which gave too much over the load allowed per square foot. Then 17 ft. 6 in., which was found to be too light, and lastly 18 ft. 6 in. square was adopted.

It will be seen that the greatest weight per square foot on base of foundation is 3.0 tons, and that the safe load allowed on the rock is 4.0 tons in that locality.

For every important and heavy structure borings should always be taken, and the ground thoroughly tested, so that there will be no chance of settling, and causing continual trouble and expense, and which can be avoided by having the advice of an expert on foundations.

It is hoped that this article will be of service to those seeking advice on this subject.

WASTE OF NATURAL GAS.

Much has been written about the saving effected by using natural gas in gas engines to generate power, instead of burning the gas under boilers to generate power from steam. Experiment has shown that the amount of gas required per hour, for the development of one horse-power, varies from 9 cubic feet, with the highest type of large internal combustion engine, to 130 cubic feet with the ordinary steam engine. In other words, the efficiency of the gas is over fourteen times as great when used in gas-engines as when used for generating steam under boilers.

The province of Ontario has reduced the waste of natural gas to a minimum by causing all abandoned wells to be plugged and by levying a tax of two cents per thousand feet, with a rebate of 90 per cent. when the gas is used.

ABUSES IN WATER FILTRATION.

The success of a water filtration plant depends, first, upon the selection of the method of purification best suited to local conditions, and second, upon the proper operation of the works after they have been installed. This subject was discussed at the last meeting of the New England Waterworks Association by Mr. Gilbert H. Pratt, chemist of the Rhode Island State Board of Health, who pointed out some of the things which contribute to the production of unsatisfactory results.

Slow sand filtration for a water high in algæ is not to be recommended, he said, because of the undue clogging of the beds, but by the use of aeration and prefilters conditions may be greatly improved. Plain sand filtration should not be relied upon to treat a very highly colored water. Rates of filtration should not be changed quickly, for such practice tends to disturb bacterial action at the surface of the bed.

A slow sand filtration plant which would handle a given water satisfactorily might, as was the case in Providence, be installed without covering the beds. As soon as a hard winter struck the plant the beds would become covered with ice, and it would be impossible to get at the surface to clean without removal of the cakes of ice. This condition occurred in Providence for a short time during 1907, finally necessitating opening the river gate, and the use of raw water for about two weeks or so before the weather moderated and before the ice could be removed. This experience resulted in steps immediately being taken to cover the beds. This experience, Mr. Pratt believes, should serve as a lesson against such open installations in New England.

One of the easiest ways to abuse a plant is to put it into the hands of inexperienced operators, especially in the case of rapid sand filters, where the supervision must be particularly close and where tests for color and alkalinity must be made to regulate the doses of chemicals used. One plant had operated for a number of years satisfactorily in a bleachery. When Mr. Pratt was consulted with regard to difficulties which were occurring he found that the parties in charge did not have an understanding of the question of alkalinity control of the plant ,and the residual alkalinity of the effluent had dropped to a point where the water was passing the plant at times in an acid condition, or at best with an extremely low alkalinity, resulting in after-coagulation in the vats and throughout the system. This condition had been caused by a mill above discharging a larger amount of acid wastes in the river than at the time the formula for operating the filters was figured. The addition of alkalinity to the water put the plant back into its former good condition.

At another installation the man in charge of the plant, for some reason or other, was assigned to night duty, and he was attempting to make his control tests for color and alkalinity at night by artificial light. This, of course, gave far from accurate results. Another trouble at this plant was that the one man was expected to operate the flow of chemicals from the tanks, which were located in the pump house, and at the same time attend to washing the filters in a filter house which was located about one-eighth of a mile away. This spreading out of the plant made it impossible for the lone operator to properly attend to the dosing, and the result was that the flow of chemicals varied from time to time, with resulting poor output from the plant.

At another plant trouble due to low residual alkalinity was found to exist, and the output contained undecomposed sulphate of alumina. Investigation showed that this operator was using an indicator solution many times too strong and the alkalinity tests which he was obtaining were absolutely inaccurate.

At still another plant the biggest difficulty discovered when troubles arose seemed to be with the application of the chemicals, which required an extremely close control on account of an influence on the color of the filtered water, as the residual alkalinity became too high. The engineer was a man who had been for years pumping water out of the reservoir under the old system, and could not be made to realize that careful supervision was necessary. He grossly neglected controlling the flow of the chemicals. These operating troubles immediately ceased when a new, competent engineer was put in charge of the plant.

The effect of an abnormal amount of organic matter or algæ in comparison with the color of the water sometimes has resulted in an under-dosing with coagulant, as this additional amount of organic matter has seemed to prevent proper coagulation with resulting incomplete removal of the constituents which it was intended to remove, and the effluent has contained alumina and abnormal amounts of color and algæ. Proper dosing in view of the above-mentioned conditions has resulted in excellent work from this plant.

Another abuse oftentimes is attempting to operate a plant with every possibility for good results, by methods which some man of limited experience may have used at some other plant, meeting entirely different conditions. Such cases have been capable of adjustment when instructions have been given which had in mind the type of plant and the raw water to be handled.

In connection with the operation of plants of the mechanical type, it is essential that the night man should be one who can be depended upon to stay awake, as a nap for an hour or two may result in throwing the whole operation of the plant out of adjustment for several hours.

CANADIAN RAILROAD EARNINGS.

The following are the approximate gross earnings of Canadian Railroads month by month.

	Canadian Pacific Railway.			Grand Trunk Railway.			Canadian Northern Railway.		
Month.	1911.	1912.	Increase.	1911.	1912.	Increase	1911.	1912	Increase.
	$	$	$	$	$	$	$	$	$
January	5,650,000	7,201,000	1,551,000	3,381,239	3,422,286	41,049	822,600	1,228,100	405,500
February	6,210,000	8,773,000	2,563,000	3,103,166	3,259,943	156,777	803,100	1,202,500	400,400
March	8,648,000	10,389,000	1,741,000	3,909,773	4,080,230	170,457	1,270,600	1,572,700	302,100
April	8,458,000	10,484,000	2,026,000	3,747,251	4,135,202	387,951	1,345,400	1,607,600	262,200
May	9,111,000	11,133,000	2,022,000	3,942,055	3,303,374	361,319	1,445,600	1,822,100	376,500
June	9,040,000	10,848,000	1,808,000	4,437,438	4,653,475	116,036	1,465,300	1,769,500	304,200
July	9,291,000	11,641,000	2,350,000	4,237,383	4,641,868	404,485	1,475,950	1,829,700	353,800
August	10,073,000	11,886,000	1,813,000	4,502,674	5,066,415	563,741	1,420,650	1,745,800	325,200
September	9,834,000	11,322,000	1,488,000	4,409,559	4,758,777	349,218	1,576,400	1,671,500	95,100
October	11,113,000	12,960,000	1,847,000	4,468,768	4,901,954	433,186	2,028,900	2,351,200	322,300
November	10,399,000	12,145,000	1,746,000	4,101,244	4,622,308	521,264	2,001,500	2,509,700	508,200
December	10,568,000	12.108,000	1,540,000	4,147,769	4,843,965	695,196	1,831,400	2,131,700	300,300

ELECTRIC RAILWAYS IN CANADA.

During the next few years, there is likely to be considerable development in electric railways in Canada. The large railroad corporations are considering the advisability of electrifying certain existing steam lines and building new electric roads for suburban service. Capitalists and charter holders are estimating the cost of linking small towns by electric roads. The present appears to be a time of preparation for the inauguration of an electric railroad era, especially in the older provinces of the Dominion. It is most marked in Ontario. The accompanying table shows to what extent the electric railroad is already in vogue in that province. The statistics are for the year 1911, the latest for which official figures are available.

The subscribed capital of twenty-eight roads in Ontario is $16,000,000. The paid-up capital totals $14,000,000, and the outstanding bonds $12,000,000. Their total liabilities are $36,737,000 and total assets $36,711,000. The operating results are interesting. With the exception of five, they all showed a surplus. The largest deficit, amounting to $421,967, was that of the Hamilton Radial. The total receipts of the twenty-eight were $8,000,000, and the total expenses $6,620,000, giving a total surplus of $1,430,000.

Passenger fares accounted for the greatest share of receipts, revenue from freight and other sources being comparatively small. It is for passenger traffic that our transportation interests are apparently agreed that electric traction is most suitable. The receipts may be summarized as below:—

Receipts from	Amount.
Passenger fares	$6,811,493
Freight	238,557
Mail service and express	8,809
Other sources	163,415

The actual operating figures are of significance to railroad men and to investors particularly. The street car systems in the large cities naturally show the largest car mileage run, Toronto leading the way in Ontario with a mileage of more than 16,000,000. The cost of operation per car mile shows some striking contrasts. The lowest figure is that of the Cornwall Street Railway, $07.5. The highest is that of the Hamilton and Dundas Railway, $43.1. Of 22 roads, the cost of operation per car mile in 14 cases exceeded $20, and in eight cases was under that amount.

The smallest length of track is that of the Huntsville and Lake of Bays Railway, which has only one mile. It serves a holiday traffic, connecting boats. Last year it carried 14,000 passengers. The greatest mileage, 110.88, is that of the Toronto Street Railway. The number of passengers carried by the electric roads of Ontario in 1911 was 181,259,748, and the year before 157,539,893.

Among the important electric roads in other provinces are the following:—

Company.	Mileage.
Halifax Electric Tramway Company	13.15
Montreal Street Railway	230.97
Quebec Railway	17.00
Winnipeg Electric Railway	119.46

Electric roads are also operated or contemplated in several cities west of Winnipeg, including Brandon, Moose Jaw, Regina, Saskatoon, Calgary, Edmonton, Lethbridge, Vancouver and Victoria. The system in the two latter cities, as well as in smaller British Columbia municipalities, is operated by the British Columbia Electric Railway. It has 234 miles of railway.

In the entire Dominion the mileage of electric roads in 1911 was 1,223. The growth of first main track mileage since 1900 is as follows:—

1902	557.59
1903	759.36
1904	766.50
1905	793.12
1906	813.74
1907	814.52
1908	902.03
1909	988.97
1910	1,047.07
1911	1,223.73

The capital liability of electric railways in Canada was increased from $102,044,979 in 1910 to $111,532,347 in 1911.

The following statement will show the facts with regard to capital liability for five years:—

	1907.	1908.	1909.	1910.	1911.
Stocks	$43,491,746	$50,295,266	$51,946,433	$58,653,826	$62,251,203
Funded debt	31,166,976	37,114,619	39,658,556	43,391,153	49,281,144
Total	$74,658,722	$87,409,885	$91,604,989	$102,044,979	$111,532,347

The gross earnings from operation for 1911 were $20,356,951.70—an increase of $3,256,162.22 over 1910.

The income for 1911 came from the following sources:—

Car earnings: Passengers, $19,130,376.22; freight, $744,179.11; mail and express, $88,233.13; other car earnings, $100,930.12. Total car earnings, $20,063,718.58.

Miscellaneous earnings: Advertising, $66,147.33; rent of buildings, etc., $22,551.98; rent of tracks, $13,650.94; rent of equipment, $58,624.40; sale of power, $43,698.24; other earnings, $88,560.23. Total, $293,233.12. Gross earnings from operation, $20,356,951.70.

The following is a summary of statistical facts, compiled by Mr. J. L. Payne, comptroller of railway statistics, Ottawa, and relating to electric railways in Canada:—

	1909.	1910.	1911.
Total mileage	988.97	1,047.07	1,223.73
Paid-up capital	$91,604,989	102,044,979	111,532,347
Gross earnings	$14,611,484	17,100,789	20,356,952
Net earnings	$4,962,501	5,383,276	6,592,335
Earnings—			
Passenger traffic	$14,080,755	16,125,995	19,130,376
Freight	$386,092	575,537	744,179
Mail and express	$110,452	68,604	88,233
Other sources	$34,185	51,241	100,930
Total operating expenses	$8,885,235	10,121,781	12,096,134
Maintenance of way and building	$643,135	797,895	920,875
Cost of motive power	$1,445,227	1,586,927	2,001,543
Maintenance of cars	$1,184,287	4,814,762	5,768,085
General operat'g charges	$5,612,041	1,406,943	1,610,099
Total car mileage	60,152,846	65,249,166	72,618,806
Passengers carried	314,026,671	360,964,876	426,296,792
Tons of freight carried		852,294	2,496,072

ONTARIO HYDRO-ELECTRIC COMMISSION.

The total revenue of the Ontario Hydro-Electric Commission for the past year reached $511,801.88. These receipts were for power delivered, including charges for administration, general expenses, operation, maintenance and interest. The expenditure reached $456,635.43; the total for the fourth quarter, with a tremendous increase in power purchased, was but $28,000 above that of the first quarter. The surplus on the year was $55,166.45, half of which was rolled up in the last quarter. This has been nominally set aside as a "depreciation reserve."

ELECTRIC RAILWAYS IN ONTARIO

Name of Railway	Capital subscribed	Capital paid up	Bonds outstanding	Other liabilities	Total liabilities	Total assets	Receipts from passenger fares	Receipts from freight	Receipts from mail service & express	Receipts from other sources	Total receipts	Total expenses	Surplus	Deficit
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Berlin & Waterloo			114,152 84	33,119 15	147,271 99	147,271 99	32,607 02		1,178 51	4,313 54	38,090 07	37,908 30	190 77	
Berlin & Bridgeport	17,400 00	17,400 00	2,400 00	14,673 92	34,473 92	34,743 92	7,029 26		115 38	129 50	7,274 14	6,764 79	509 35	
*Brantford Street Railway														
Cornwall Street	200,000 00	200,000 00		30,199 51	230,199 51	230,199 51	16,620 75	9,450 84		3,062 62	29,134 21	22,212 35	6,921 86	
Galt, Preston & Hespeler	100,000 00	31,310 00	601,852 47	259,816 46	892,978 93	892,978 93	76,013 88	77,561 05	1,875 22	7,891 09	163,341 24	97,789 55	65,551 69	
*Grand Valley	1,100,000 00	1,100,000 00	688,800 00		1,788,800 00	1,788,800 00	81,153 00	4,455 31		2,324 58	87,932 89	79,824 40	8,108 49	
Guelph Radial			103,775 19		103,775 19	124,585 93	28,338 16	1,070 85		958 38	30,367 39	30,367 39	1,960 65	
Hamilton & Dundas	100,000 00	100,000 00	100,000 00	158,773 30	358,773 30	358,773 30	49,887 74	788 16	148 00	2,673 44	53,497 64	49,813 29	3,684 35	
Hamilton Street	205,000 00	205,000 00	500,000 00	270,812 97	975,812 97	975,812 97	405,030 57			5,404 08	110,434 65	323,789 48	86,645 17	
Hamilton, Grimsby & Beamsville	235,000 00	235,000 00	150,000 00	61,727 49	446,727 49	446,727 49	78,679 42	35,209 28	550 00	4,905 53	119,344 23	117,906 55	1,437 68	
Hamilton Radial	111,150 00	111,150 00	1,160,000 00		1,271,150 00	1,271,150 00	152,985 44				152,985 44	174,953 30		21,967 86
Huntsville & Lake of Bays	50,000 00	27,800 00			27,800 00	27,800 00	1,825 45	2,692 44	25 00		4,542 89	4,634 94		92 05
International Transit Co	150,000 00	150,000 00	290,000 00	129,420 63	569,420 63	529,420 63	68,018 69			8,202 37	76,221 06	55,344 02	20,877 01	
Kingston, Portsmouth & Cataraqui	83,100 00	83,100 00		106,910 00	106,910 00	100,000 00	30,959 60			1,139 63	32,099 23	36,597 10		4,497 87
London Street	750,000 00	552,000 00	575,000 00	102,965 83	1,229,965 83	1,229,965 83	261,200 43			5,615 19	266,815 62	252,119 65	14,695 97	
Niagara Falls, Park & River	925,000 00	925,000 00	1,073,000 00		1,998,000 00	1,998,000 00	151,249 57			18,225 95	169,475 52	115,235 57	54,239 95	
Ottawa Street	1,247,700 00	500,000 00	500,000 00		1,747,700 00	1,747,700 00					787,573 27	532,311 64	255,261 63	
Peterboro' Radial	100,000 00	100,000 00	50 000 00	37,242 32	187,242 32	187,242 32	36,380 20			680 03	37,060 23	32,839 41	4,220 82	
Port Arthur & Fort William			838,147 20	101,065 01	939,212 21	939,212 21	140 058 31	12,226 50	379 16	3,584 44	156,248 41	136,297 18	19,951 23	
Sandwich, Windsor & Amherstburg	297,000 00	297,000 00	490,000 00	278,521 57	1,065,521 57	1,065,521 57	187,028 74		800 00	37,150 92	224,979 66	128,609 25	96,370 41	
Midland Terminal	250,000 00	250,000 00		27,321 72	277,321 72	277,321 72		20,902 50			20,902 50	25,508 24		4,605 74
Sarnia Street	90,000 00	90,000 00		116,712 21	206,712 21	206,712 21	35,351 47	6,040 21	1,555 00	3,421 92	46,368 60	40,728 73	5,639 87	
St. Thomas Street			57,482 29	17,696 01	75,124 30	75,124 30	14,594 96			1,748 08	16,343 04	24,828 25		8,485 21
Toronto Street	8,000,000 00	8,000,000 00	3,998,326 66	5,223 581 91	17,221,908 57	17,221,908 57	1,549,160 88			41,081 17	4,590,245 05	3,874,915 21	715,329 84	
Toronto Suburban	80,000 00	80,000 00		135,638 92	215,638 92	215,638 92	53,967 12			10,062 13	64,029 25	52,174 64	11,854 61	
Toronto & York Radial	2,000,000 00	2,000,000 00	1,640,000 00	979,192 20	4,619,192 20	4,619,192 20	353,352 71	68,159 76	2,182 92	837 50	424,532 89	367,018 95	57,513 94	
Thurlow Railway Co														
*Woodstock, T. V. and I.														
	16,011,350 00	14,974,760 00	12,932,882 65	8,085,391 13	36,737,633 78	36,711,801 52	6,811,493 37	238 557 20	8,809 19	163,415 09	8,009,848 12	6,620,492 18	1,430,965 32	39,648 73

Name of Railway	Car miles run	Maintenance of way and buildings	Cost of motive power	Maintenance of cars and equipment	General operating expenses	Charges on income, including interest	Total expenses	Cost of operation per car mile	Length of track switches and turn outs 1910	Length of track switches and turn outs 1911	Car mileage 1910	Car mileage 1911	Passengers carried 1910	Passengers carried 1911
		$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$						
Berlin & Waterloo	98,992	1,864 82	6,177 06	4,170 37	14,298 69	11,397 36	37,908 30	38 3	4.40	4.00	90,408	98,992	688,304	774,941
Berlin & Bridgeport	32,000	207 50	1,685 96		3,873 59	997 74	6,764 79	21.1		3.20	not given	32,000	145,587	145,587
*Brantford Street														
Cornwall Street	286,466	1,020 83	2,764 64	3,124 45	15,302 43		22,212 35	07.5	6.50	6.50	192,445	286,466	357,116	340,677
Galt, Preston & Hespeler	275,769	13,005 34	20,329 04	10,846 22	47,431 56	6,177 39	97,789 55	35.4	26.42	26.42	219,977	275,769	923,167	994,568
*Grand Valley Railway	333,417	4,787 00	20,534 60	6,405 82	45,581 49	2 515 49	79,824 40	23.9	40.43	40.24	358,593	333 417	1,026,354	1,095,488
Guelph Radial Railway	192 500	1,764 43	4,665 13	4,771 92	12,757 18	4,448 08	28,406 74	14 7	6.33	6.33	192,500	192,500	605,476	668,952
Huntsville & Lake of Bays	1,350	548 06	443 02	250 00	1,654 61	1,739 25	4,634 94	34.9	1.00	1.00	1,110	1,350	12,667	14,000
Hamilton & Dundas Railway	115,434	4,555 60	4,470 67	2,263 04	23,424 34	15,099 64	49,813 29	43 1	7.25	6 98	111,176	115,434	511,344	595,896
Hamilton Street Railway	1,652,498	11,734 55	42,451 63	40,172 62	161,246 22	68,184 46	323,789 48	19.6	22.29	22.29	1,647,524	1,652,498	9,123,699	10,625,054
Hamilton, Grimsby & Beamsville	347,054	14,873 84	13,163 20	14,040 88	50,308 71	25,522 83	117,909 46	33.9	23.00	22.60	291,212	347,054	508,091	622,915
Hamilton Radial Railway	513,712								25.00	33.69	472,236	513,712	1,135,291	1,442,551
International Transit Co	314,806	3,195 72	6,999 88	4,548 22	23,989 44	16,610 76	55,344 02	37.4	3.90	3.90	305,170	314,806	1,159,789	1,650,540
Kingston, Portsmouth & Cataraqui	199,680	3,579 41	3,494 04	6,338 48	18,041 43	4,571 87	36,025 23	18.1	8.00	8.00	199,680	199,680	1,368,258	776,736
London Street	1,432,858	21,751 01	35,010 81	28,963 45	96,928 40	69,475 98	252,129 65	17.6	33.44	33.25	1,421,735	1,432,858	6,718,167	7,210,642
Niagara Falls, Park & River	333,195	24,075 92	5,971 64	4,691 33	47 101 08	33,395 60	115,235 57	34.5	24.11	24.11	350,512	333 195	1,295,485	1,331,645
Ottawa Street	4,171,449								44.54	47.42	3,924,542	4,171,449	15,987 849	23,716,883
Peterboro' Radial	255,218	1,683 30	1,500 00	3,926 33	21,597 28	4,132 50	32,839 41	12.8	5.24	5.24	257,063	255,218	710,853	810,124
Port Arthur & Fort William	654,015	10,239 19	19,743 10	18,460 52	49,083 20	38,771 17	136,297 18	20.8	19.25	22.33	491,766	654,015	2,832,426	3,407,918
Sandwich, Windsor & Amherstburg	875,040	15,442 83	13,257 73	10,884 52	54,824 17	34,200 00	129,609 25	14 8	36.06	36.06	854,794	875,040	3,031,244	3,428,634
Midland Terminal									4 00	4.00				
Sarnia Street	143,990		5,670 11	2,654 90	22,579 32	9,824 40	40,728 73	28.3	9.25	9.25	143,990	143,990	723,566	800,210
St. Thomas Street	281,700	1,859 98	4,200 00	2,437 96	16,330 01		24,828 25	08.81	7.70	7.70	267,502	281,700	353,026	534,562
Toronto Street	16,354,871	85,175 59	369,501 97	308,994 20	1,569,646 65	1,541,596 80	3,874,915 21	23.7	107.71	110.88	15,391,301	16,354,871	103,480,724	114,824,464
Toronto and Suburban	234,128	6,503 51	6,000 00	4,570 25	23,872 73	11,228 15	52,174 64	22.3	10.26	10.26	227,113	234 128	1,047,191	1,309,965
Toronto & York Radial	1,118,000	23,836 37	56,061 49	44,949 69	124,760 29	117,411 11	367,018 95	32.8	81.05	81.05	1,106,215	1,118,000	3,794,219	4,136,796
*Thurlow Railway									5.43	5.43	not given			
*Woodstock, T. V. & I.														
	30,018,142	251,704 80	644,095 72	527,465 17	2,444,632 82	2,017,300 58	5,886,199 39		563.56	582.13	28,518,554	30,218,142	157,539,893	181,259,748

Grand Valley System operates Brantford Street Ry., 8.95 miles, Woodstock, Thames Valley and Ingersoll, 11.50 miles, Grand Valley Ry., 20.75: 41.20 miles.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc. MANAGING EDITOR — A. E. JENNINGS ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc. CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, JANUARY 1[illegible] No. [illegible]

CONTENTS OF THIS ISSUE.

THE CHICAGO DRAINAGE CANAL DECISION.

In an elaborate opinion denying the petition of Chicago for permission to divert from Lake Michigan increased water, Secretary of War Stimson deals with the principal points of argument which have developed during the negotiations carried on in the past few months.

We treated this question of increased diversion of water for the Chicago Drainage Canal editorially in our issues of April 25th and July 18th, 1912, and we are glad to note that the arguments therein presented have been given due weight in the decision arrived at. Secretary of War Stimson states that he has reached the following conclusions:—

> That the diversion of 10,000 cubic feet per second from Lake Michigan, as applied for in this petition, would substantially interfere with the navigable capacity of the navigable waters in the Great Lakes and their connecting rivers.
>
> That being so, it would not be appropriate for me, without express Congressional sanction, to permit such a diversion, however clearly demanded by the local interests of the sanitation of Chicago.
>
> That on the facts here presented no such case of local permanent necessity is made evident.
>
> That the provisions of the Canadian treaty for a settlement by joint commission of "questions or matters of difference" between the United States and Canada offer a further reason why no administrative officer should authorize a further diversion of water, manifestly so injurious to Canada, against Canadian protest.

The opposition to the application of the Sanitary District for permission to divert 10,000 cubic feet of water per second, instead of the 4,167 feet, at present authorized, was pronounced, on the part of twenty-three cities and six States, the navigation interests of the Great Lakes, the Canadian Government and private interests, and Mr. Stimson states that this opposition marks a distinct change in the situation from the time the canal was projected.

The specious argument which formed the basis of Mr. Isham Randolph's report in behalf of the Sanitary District, that the reduction in depth on the lakes caused by the increased diversion would be of no consequence, in view of the fact that greater natural changes occur through winds and other conditions, is taken at its true worth, and Mr. Stimson states the fact that the oscillations would remain as before, that low water would fall lower and high water would rise less high, and the average draught of vessels would have to be diminished to that extent. He reiterates that every drop of water taken out of the lake at Chicago tends to nullify the costly improvements on the harbors, etc., as well as to inflict even greater loss upon the navigation interests.

Secretary of War Stimson is to be congratulated on this eminently fair and just opinion. It is seldom that a report comes to hand which shows such fair-mindedness and a desire to protect all the interests affected. From Canada's standpoint the decision could not be improved upon. Secretary Stimson notes the fact that the International Waterways Treaty of 1909 gives Canada certain rights which must be respected. We are glad to note that he has shown this respect in his decision.

THE PUBLIC HEALTH ACT OF ONTARIO.

In this issue under the heading, "Changes in the Public Health Act of Ontario," will be found the important changes in Public Health legislation which took effect at the beginning of this year in the Province of Ontario. We are in hearty sympathy with all of these, but we are sorry to note that as yet no provision has been made for the employment of an engineer to work in co-operation with the Provincial Board of Health. In the editorial columns of the issue of September 19th, 1912, we stated that the necessity for the securing ot the assistance of expert sanitary engineering experience to co-operate with Provincial Boards of Health was very urgent.

We note that plans for the establishment and extension of waterworks and sewerage systems must be approved by the Ontario Board of Health before any debentures can be issued to raise money for these purposes. The Board may direct as to the maintenance, repairs and improvements of such systems, and upon the certificate of necessity from the Board, work may be undertaken in the interests of public health without a vote of the ratepayers.

There is little question that this legislation will aid towards placing the control of the pollution of waterways in the hands of the Board of Health, a result which will mean safer drinking water supplies, and, therefore, reduction in the number of cases of deaths from typhoid fever and other water-borne diseases.

We are unable to see how this legislation can be carried out with the present staff of the Ontario Provincial Board of Health. It is unfair to the engineering profession that their plans should be submitted to members of the medical profession without competent engineering advice available. If this legislation is to be effective, and it is the desire of everyone that it should be effective, the Board of Health must have on their staff a thoroughly competent hydraulic and sanitary engineer, or the advice of such a man must be available for them at such times as they require.

EDITORIAL COMMENT.

We wish to remind all members of the Canadian Society of Civil Engineers of the coming Annual Meeting, to be held in Montreal on January 28th, 29th and 30th. Every member should make a strong effort to be present.

* * * *

Quebec has made a distinct step forward in its treatment of the Good Roads question. It was announced this week that Mr. J. O. Mousseau, member of the Provincial Parliament for Soulanges, has been appointed Minister of Good Roads. This new provincial portfolio should be the means of concentrating the handling of the construction and maintenance of good roads throughout Quebec. The province has voted $10,000,000 for the construction of good roads. This, coupled with the fact that a Cabinet Minister will be directly in charge of the work, should do much to improve road conditions and to aid in opening up the province.

* * * *

The Board of Control in Toronto has recommended to the City Council that a by-law be passed to sanction the erection of a seventeen-story building on King Street. They very naively state that the building would be of fireproof construction throughout. This question of the height of buildings in this city should be settled once and for all, by taking it out of the hands of the Board of Control or the City Council to give permission to erect a building over ten stories high. Toronto streets are far too narrow to permit of the increased congestion of traffic and the evil effects on sunshine, incidental to the erection of such structures.

PROGRAMME OF ANNUAL MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting for the election of officers and members of council for 1913, and for the transaction of business, will be held as follows in the rooms of the society, 413 Dorchester Street West, Montreal.

Tuesday, January 28th.—10 a.m.—Meeting for the nomination of scrutineers; receiving the report of council; reception and discussion of reports of committees, and transaction of the general business of the society.

1 p.m.—Adjournment for luncheon, to which the visiting members are invited by the members resident in Montreal.

3 p.m.—Continuation of the business meeting for the discussion of reports, etc.

4 p.m.—An address by the retiring president, Mr. W. F. Tye.

8 p.m.—Smoking concert in the new quarters of the society, 176 Mansfield Street. Complimentary.

Wednesday, January 29th.—Visit to the Montreal Steel Works. The party will leave the Windsor Hotel at 10 a.m. sharp. By the courtesy of the Montreal Tramways Company special street cars will be provided to convey the party to and from the works at Longue Pointe.

3 p.m.—Business meeting. Discussion of reports.

8 p.m.—Annual members' dinner.

Thursday, January 30th.—10 a.m.—Meeting for the reception of reports of scrutineers. Continuation of the business of the annual meeting.

2.30 p.m.—The meeting will reassemble, if necessary, for the conclusion of business. On adjournment a meeting of the council will take place.

By the kindness of the railways of the Eastern Canadian Passenger Association, members and their families who have paid a full one-way first-class fare going to the meeting in Montreal, will be returned free on presentation of a Standard Convention certificate signed by the ticket agent from whom a ticket has been procured at the point of commencement of the journey. The certificate is to be endorsed by the secretary of the society, and to be vised by a special agent of the Passenger Association who will be in attendance at the meeting from 3 p.m. to 6 p.m. on Wednesday and Thursday, January 29th and 30th. A fee of 25 cents will be charged by the Passenger Association in each case. Tickets may be purchased and are available three days before the commencement of the meeting and the return journey may be made three days after its conclusion.

A further extension of time will be granted to persons residing west of Fort William, making the free return available for 15 days after the close of the meeting; the ticket to Montreal having been purchased at any time and receipt obtained therefor on the Standard Convention form as above.

Tickets to the luncheon on Tuesday and to the annual dinner on Wednesday may be procured at the rooms of the society. Prices: Luncheon, $1.50 to local members; dinner, $3.50. Secretary, Prof. C. H. McLeod.

DEVELOPMENT WORK ON THE C. P. R.

The Canadian Pacific Railway again enjoyed a period of progress and development during its past fiscal year, which ended on June 30th, 1912. Sir Thomas Shaughnessy, the president and chairman of the company, had a pleasing statement to submit to the shareholders. Most interesting to the country at large were the extensions and new connections, made and proposed by the company. For the purpose of securing a shorter and more expeditious route between Quebec and points in New England, served by a friendly connection, the Boston and Maine Railroad, the directors thought it advisable to lease the Quebec Central Railway, forming the connection between Sherbrooke and Levis, together with branch lines from Beauce Junction to St. Sabine, and from Tring to Megantic, all in Quebec, making a total of about 253.5 miles of railway, at a rental based upon the interest on the outstanding 1st, 2nd and 3rd mortgage bonds of the Quebec Central Railway Company, and a dividend on the outstanding capital stock of that company at four per cent. per annum for four years from July 1st, 1912, and thereafter at the rate of five per cent. per annum.

The Shuswap and Okanagan Railway, 51 miles in length, extending from Sicamous Junction, on the main line in British Columbia, to the head of Okanagan Lake, was leased to the company on its completion in 1892 for a period of 25 years, and it was a condition of the lease that the company should pay by way of rental forty per cent. of the gross earnings of the line, as defined in the lease, in quarterly amounts.

The Georgian Bay and Seaboard Railway, recently built under Canadian Pacific Railway auspices between Victoria Harbor, on Georgian Bay, and Bethany, Ontario, to provide a shorter and more economical lake and rail route between Western Canada and the Atlantic Seaboard, proved more expensive than was anticipated, due to the character of the line that it was finally determined to construct and to other conditions. The power conferred by parliament on the Georgian Bay and Seaboard Railway Company to issue bonds for the purposes of its undertaking was originally limited to $30,000 per mile, but at the last session of parliament this amount was increased to $55,000 per mile, and the directors have entered into a supplementary agreement with the Georgian Bay and Seaboard Railway Company to increase the limit of that company's bond issue, upon which this company has, by virtue of the lease approved October 3rd, 1906, agreed to pay interest by way of rental, from $30,000 to an amount not exceeding $55,000 per mile of railway.

Instead of continuing the double track from Glen Tay to Agincourt, on the Ontario and Quebec Railway between Montreal and Toronto, it has been decided to secure a line between these two points that will serve the territory further south, and will reach several important towns on the north shore of Lake Ontario. An agreement has, therefore, been made with the Campbellford, Lake Ontario and Western Railway Company for the construction, under the company's supervision and control, of that company's railway, 184 miles in length, between Glen Tay and Agincourt, both in Ontario, and for the lease of the railway when completed to the company for a period of 999 years, at a rental equivalent to four per cent. per annum on the bonds of the Campbellford, Lake Ontario and Western Railway Company.

The present route between points in the Kootenay and Boundary Creek Districts, of British Columbia, and the Pacific Coast is long and expensive, and the best means of securing a more direct route has engaged the attention of the directors for some time past. The Kettle Valley Railway Company, having a Dominion charter, covering the territory between Midway, the terminus of your Boundary Creek Line, and Merritt, on your Nicola Line, undertook to build the railway between these points, under the advice and to the satisfaction of the directors, upon condition that the company would lease the line, approximately 270 miles in length, and the branch line along the North Fork of the Kettle River, 24 miles in length, whenever and as soon as the Kettle Valley Railway Company is competent to make a lease, paying by way of rental the interest at four per cent. per annum on the bonds of the Kettle Valley Railway Company, any subsidy received from the Dominion or Provincial Government, or from any other source, to be applied on an agreed basis towards the cost of the construction of the railway and a corresponding reduction in the amount of bonds to be issued. This line will give access to a large and important section of the province in which development should quickly follow railway facilities.

The amounts appropriated for new works, exclusive of railway construction, were abnormally large, in the year under review. For the enlargement of terminals, additional shops, second tracks, sidings and improvements of every variety calculated to improve the efficiency of the railway system, and to facilitate the movement of the large and increasing traffic, the amount of $30,000,000 was authorized to be expended and orders for locomotives and cars, representing an expenditure of $25,750,000, were placed. Many of these works cannot be completed with the season, with the limited amount of labor available, but no effort is being spared to meet the convenience of the public and to strengthen the position.

The shareholders last year sanctioned a lease of the Kingston and Pembroke Railway, extending from Renfrew, on the company's main line west of Ottawa, to Kingston, on the St. Lawrence River, and from Godfrey village to Zanesville Mine, in Ontario, a total distance of 107.5 miles; a lease of the Alberta Central Railway, extending from Red Deer to Rocky Mountain House, in Alberta, a distance of 65 miles; an agreement with the St. Mary's and Western Ontario Railway Company cancelling existing arrangements and substituting a lease of their property for a period of 999 years at a rental equivalent to four per cent. per annum on bonds issued or to be issued by that company with your consent to an amount not exceeding $25,000 per mile of their railway; and a deed of conveyance of the Cap de la Madeleine Railway, about 4 miles in length, connecting the railway near Three Rivers, in Quebec, with Cap de la Madeleine, on the St. Lawrence River, and with the Wayagamack Pulp and Paper Company's works.

An indenture of lease from the government of New Brunswick, as lessor, to the company, as lessee, of the New Brunswick Coal and Railway for a term of 999 years at a rental of fifty per cent. of the net earnings of the said railway, as defined and calculated in the said proposed lease, will be submitted for your sanction. This railway extends from a point in the vicinity of Minto, in the County of Sunbury, to a point of junction with the Intercolonial Railway, near Norton, in the County of Kings, in the Province of New Brunswick, a distance of approximately 58 miles, and will form a portion of a connection between Canadian Pacific Railway and a coal mine in New Brunswick, now in process of development.

The following branch lines of railway in Manitoba, Saskatchewan and Alberta are being, or will be extended, viz., Boissevain to Lauder, 37 miles; Weyburn Lethbridge branch, 125 miles; Kerrobert northeasterly branch, 11 miles; Wilkie Englia branch, 4 miles; Swift Current Northwesterly Branch, 80 miles, Suffield Southwesterly Branch, 55 miles.

THE MONTREAL TUNNEL FOR THE CANADIAN NORTHERN.

S. P. Brown, M. Am. Soc. C.E., M. Am. Soc. M.E., managing engineer, Mackenzie, Mann and Co., and chief engineer, Canadian Northern Montreal Tunnel and Terminal Co., read a paper on tunnelling before the Canadian Railway Club in Montreal recently in which he dealt with the subject most exhaustively, covering its history and the questions of classificaton, surveying, design, ventilation, signals, tracks, construction, plant, excavation, and linings very thoroughly. Following are extracts which refer particularly to the C.N.R.'s Montreal tunnel.

Entries into cities, where natural surroundings make tunnels imperative where city ordinances prohibit grade crossings, where land values do not allow of a private right of way for an open cut with bridges at street crossings, or where grades or cost of construction and maintenance make an elevated viaduct inadvisable or impossible.

The Canadian Northern is just completing its transcontinental system, for which terminal facilities in Canada's principal city are essential, especially as this city is the main eastern seaport during the busiest half of the year. Montreal's natural location, between the St. Lawrence River and Mount Royal, made the problem of entry appear complicated. To enter from either end of this narrow strip meant a detour that was undesirable, and might possibly have resulted in two separate stations for the east and west-bound traffic. Grade crossings were out of the question. Cut, cut and cover subway, or elevated viaduct would have necessarily been of considerable length, which would have been difficult and expensive in many ways. The natural alternative was a tunnel; and as by developing the country back of the mountain, suburbanly, for Montreal's rapidly increasing population, much of the expense of the improvements could be covered, it was the only logical course. Furthermore, the topography of the city—combined with the distribution of business activity of different sorts—made the actual terminal location, yards, etc., equally logical and simple.

The line of the Canadian Northern Montreal Tunnel and Terminal Co., from its junction with the main line of the Canadian Northern Quebec Railway—near the Jacques Cartier Union Railway—is depressed through the new town of Mount Royal to the tunnel portal, where it passes under the C.P.R. belt line, about a mile from the latter's Outremont yard. From this point the tunnel goes down at a 0.6 per cent. grade, in an almost due easterly direction, to the McGill College grounds, where it curves into McGill College Avenue, which leads to the main passenger terminal, situated in the blocks between Cathcart and Lagauchetiere Streets and Ste. Monique and Mansfield Streets. The grades and elevations are such that this tunnel passes under St. Catharine Street, with ample room for a future rapid transit subway above it, and the tracks are able to be carried level through the station and over the lower town on the proposed viaduct, where a yard for light and perishable freight is contemplated, to connect with the proposed Harbor Commissioners' elevated and a possible bridge across the St. Lawrence River.

Two tracks will run both east and west from the main passenger station. The tunnel is something over three miles long, the viaduct about a mile long. The passenger station yard will be about a quarter of a mile long, with platforms over 1,000 feet long and an area of about nine acres. Local passenger stations will be situated down town and back of the mountain, as traffic demands. The main yard will be located near the Back River, where the electrical transfer yard will also be situated. There will also be a delivery yard in Mount Royal and an elevated yard in the commercial part of Montreal.

The designs for the Mount Royal tunnel are not yet completed, but it is probable that both twin tunnels and double track sections will be used, depending on the ground. Where the rock is of the proper character to permit it, the tunnel may be left unlined, although this cannot yet be determined. The minimum clearance has been limited to 16½ feet above the rail, but the standard tunnel clearance will be 17½ feet. The standard clearance in width is 6 feet off the centre line of track, which may be slightly reduced near the bottom as, for instance, at station platforms.

In the twin tunnel, centre walk-ways will be provided at about the level of the coach floors, and cross passages will be cut through the dividing wall, at intervals, for communication between the twin tubes. Refuge spaces are allowed for track men under the walk-ways. The ducts will be carried in the centre wall. The relation of the train cross section to the tube area will be approximately 50 per cent.

In the double track section the two tracks will be separated by the duct bench, which is the same height as the centhe walk ways in the twin tunnel, so that in case of a derailment one train cannot block both tracks.

The studies for electrification have not yet been completed, so that there is not much to be said on this subject. Owing to the climatic conditions outside the tunnel, it is improbable that a third rail will be used on the ground, which will probably force the adoption of some form of trolley. This means high voltage, either direct or alternating current. Great strides have been and are now being made in high voltage, direct current railway work and, until very careful and exhaustive studies have been completed, no decision can be made. This is important in the final design of tunnel cross sections, as the amount of head room for 10,000 volts alternating is quite different to that required for 1,500 volts direct current.

In the Mount Royal tunnel, where soft ground is encountered, a cap and post system of construction will probably be used, owing to the location of the rock surface; this running in general fairly near the roof line permits the full width timbering to be done without shifting posts, which rest directly on the rock. As fast as the roof excavation can be carried on in this manner, the arches will be built, so that the roof will be absolutely protected. After the arches are in, the lower excavation will be removed and arches underpinned, where necessary.

The plant for the Mount Royal tunnel will be quite complete. The compressor plants at each end consist of one direct connected cross compound unit of 2,200 cu. ft. per minute capacity, driven by a synchronous motor and three belt driven cross compound units of 1,100 cu. ft. per minute capacity, with induction motors. The power is three phase, 62½ cycles at 2,200 volts. Pumps, drills and some small motors are run by air. Most power used, however, is electrical. The drills used are the precussive type with the water attachment built largely of steel, to reduce their weight Horizontal bars are used to support the drills, and carriages are being made to handle the full drilling outfit for each heading.

The muck cars are 3 ft. gauge, very low and narrow. They are built with a 3 ft. wheel base, 18 in. wheels and springs on the axles. Both gasoline and electric locomotives will be used. Part of the tunnel muck will be crushed for concrete stone and ballast; part being used for fill and subfoundation work. The crushers are gyratory and roll hammer types, to give the desired grades, and both revolving and oscillating screens will be used over the bins.

The cages used at the shafts are of the counter balanced automatic dumping types, with electric hoists. These are designed for a capacity of about 800 cu. yds. per day.

The shops consist of a blacksmith shop, equipped with an air hammer, shears, punches, drill sharpening machinery and the usual forges; machine shops equipped with large and small lathes, a shaper, radius drills, saws, pipe machine, emery and grindstones, etc.; carpenters' shops, with band circular saws and drill repair and testing shops, as well as garage for the maintenance, storage and repairs of automobiles and auto trucks.

The method of excavation adopted in the Mount Royal tunnel is a bottom centre heading, with breakups at intervals where the full sized tunnel section will be developed. The heading is driven by the horizontal bar method. Later, a carriage and other auxiliary apparatus is expected to be used, as described under plant. At the breakups, jumbo timbers will be placed in the heading so that traffic can be maintained and the upper portion of the tunnel stoped down on the top of this and run directly into cars in the heading by gravity. As many of these breakups will be opened as are found necessary to keep up with the heading progress.

The firing is done electrically, but an effort is being made to get some special fuses with electric igniters, by which the cut may be fired electrically, at the same time igniting the time fuses of the relievers and line holes. This should give a better result than the ordinary time fuse method, without its accompanying risk, and will relieve the men from the necessity of going back into the smoke to load the later rounds.

In the Mount Royal tunnel, at present, the average progress at the west end is 20 ft. per day. In the east end, where the ground is rather bad, requiring timbering, and where no shooting is allowed at night, on account of public annoyance, the average progress for the last two months was 12 ft. per day. Heading 9 x 12 ft., 4 cu. yds. per foot. No drill carriage: precussive drills used with water attachment. 24 in. gauge temporary muck cars still in use.

THE RAT AND PUBLIC HEALTH.

By Lyman B. Jackes.

Doctors and health staticians have not as yet determined the position and rating of the rat on the list of disease conveyers and distributors. It is looked upon with suspicion and distrust by medical authorities in ocean ports and at other points of entrance for imports from foreign countries, but its exact facilities and adaptabilities for disease transmission are not understood.

Even aside from its supposed, and quite properly supposed, ability to transmit pathogenic organisms from district to district and from country to country, the rat is the source of immense annual losses in the industrial and agricultural worlds.

The word "rat" usually implies the brown rodent which we are accustomed to see in sewer approaches, barns, basements and stables, but this is but one member of the species Mus, which numbers about one hundred and fifty, all of which are known as rats or mice, according to the linear dimensions of the specimens.

The rat is indigenous to but a few portions of the earth, and this accounts for its non-mention in the Scriptures and other ancient writings with which we are acquainted, excepting the Chinese, and China would appear to be the starting point of rat migration and consequently for the introduction of diseases of a specific eastern nature into Europe. From Europe the pest only waited for the advent of systematic shipping to all quarters of the globe.

The brown rat's entrance into Europe was a comparatively recent occurrence, taking place about the year 1715, when an innumerable hord succeeded in swimming the Volga River, Russia, which is situate at the base of the Ural Mountains, in extreme Eastern European Russia.

This extensive migration of the rat is characteristic of the specie when pressed by hunger, and is an extremely dangerous aspect of the habits and tactics of the rodent.

Prior to the entrance of the brown rat into Europe, a smaller member of this order, known as the black rat, made extensive inroads to that continent about the year 1300. It may be a coincidence, but medical historians are not of that opinion, that the great Black Death which broke out in Europe a few years later and ravaged England from August, 1348, to Christmas, 1369. This loathsome affliction had carried off 66 per cent. of the population of Continental Europe before its introduction to England.

From historical writings, it is generally understood that this plague was of a bubonic nature, and as this is a disease, oriental in the strictest sense of the word, and has since been conveyed to European cities with frightful death lists resulting, there is probably strong grounds for such suspicion, but the most noted feature about this transmission is the well-grounded belief in the theory that it is introduced by rats carried in the holds and cargoes of ships coming from eastern ports. For this reason, during a recent outbreak of this loathsome disease in Continental Europe, all ships coming into British ports were held up before docking and a strong mixture of sulphur dioxide pumped into the hull in order that all rats might be suffocated.

If the rat were of an order that yielded easily and readily to death-dealing tactics, this would be a fairly good means of exterminating the pest, but such is not the case, for not only is the rat in itself difficult of killing, but the reproduction facilities of this animal are extraordinary in the extreme; one pair of rodents will on an average have about seventy-two young annually.

In the selection of food the rat is omnivorous and eggs, (which the rat can convey for very considerable distances unbroken) young birds of all varieties, fish, grains, cooked foods, small domestic animals, are all devoured with equal ease. Considering the facts connected with the rat and his properties of destruction, aside from his place in the medical health fields, the Canadian Government have decided that it would be beneficial to have this pest exterminated if at all possible, and with this end in view Mr. W. R. Reek, B.S.A., of the Ontario Agricultural College, Guelph, Ont., visited the Pasteur Institute in Paris in order that some experiments on rat extermination might be examined and witnessed.

The French scientists have been working for several months on a virus which would be contagiously deadly to rodents and harmless to other animals and man. The virus used for these experiments is of a bacteriological nature, and is contained in large bottles containing bouillon on which these organisms thrive. In actual use the contents of the bottle were diluted with water and scattered over oats and other foods which the rats were likely to eat. In a very short time a rat that has eaten of this grain dies suddenly of diseased throat, and this disease is transmitted with wonderful rapidity to other rats coming in contact with the dead one, and as it is a natural habit of the rat to maul and bite the body of a dead specimen of their own species, this would appear to be the great point in the application of the virus.

It is interesting to note that the French government is contemplating the enactment of a law which will enforce the usage of this material annually in every district. It has met with great success in underground railways, restaurants and

warehouses in London and Paris. In some of the banana plantations in Central America, where rodents have been attacking the roots, this virus has been used with satisfactory results.

Encouraged by the success which the French scientists have achieved, the Austrian government is going to carry on extensive experiments shortly, and there appears to be no reason to prevent its use in Canada.

BOOSTER PUMPS.*

By H. E. Cole.†

The determination of the proper presure to be maintained in any given waterworks system is often a very difficult one, and even when settled frequently results in general dissatisfaction for a large percentage of the consumers. It seems, therefore, that some time could profitably be spent in the study of ways and means of supplying the demand of those who are so located that the pressure of the system will not give satisfactory service.

There are at least three kinds of consumption requiring booster service:—

First—Tenants of tall buildings which are located on streets where the service is sufficient for ordinary requirements, but owing to the height of the building the normal pressure of the system is inadequate. In this class apparatus is usually installed by the owner of the building to boost and store a sufficient capacity for ordinary requirements.

Second—Small sections of a city's or town's population are frequently located on elevations higher than the reservoir or where the pressure is insufficient for their requirements. This is a condition which a great many companies have to face. It may be considered under seven heads.

(1) The number and class of consumers to be supplied determines the capacity of plant to be installed.

(2) The distribution of the population determines the location of the booster station and reservoir with reference to the main bringing in the supply. It furthermore makes necessary a careful study of first cost of large mains, low friction losses or of small mains, and necessary increase in pressure to overcome friction head.

(3) The presure to be maintained has a very important bearing, as it determines largely the character of the reservoir to be used as well as the type of pump to be installed.

(4) The importance of uninterrupted service has its effect on both the quality of apparatus and on the duplication of units as well as on the power employed and attendance.

(5) The amount of storage required usually determines the kind of reservoir which shall be used. If the pump is to operate automatically then the storage required may usually be very much smaller than otherwise. The determining factor, then, is the amount of storage required for fire protection or to supply the sections during the probable shutdown of the pumps or loss of power from any cause.

(6) The kind of power available materially affects the cost of operation and the adaptability of the power.

(a) If steam is the power used and coal the fuel the coal must usually be hauled a long distance, and at a high elevation steam must be kept up most of the time. An attendant must be present practically all the time the pump is in operation. The smoke nuisance must also be contended with.

(b) Natural gas for steam, when available, is far better than coal, as hauling is practically eliminated, and there is no smoke. In such cases, however, a small amount of coal should be kept in reserve and the boiler equipped to use both gas and coal in order to be prepared for a shortage of gas or other interruption of the supply. The necessity for a constant attendant, however, still remains.

(c) Natural gas when used in an internal combustion engine to drive a power pump makes one of the best powers for this service, as the fuel cost is usually the least and mechanical efficiency of equipment is relatively high. The chief disadvantages are frequent attention required, although far less than for steam—cannot be operated automatically without serious complications, although it is not only possible, but entirely practicable to make the pump operate automatically, as required, by keeping the engine running continually. Whenever gas engines are used it is good policy to provide gasoline attachments so that the engine could be operated on gasoline or other liquid fuel on very short notice.

(d) Gasoline or other distillate when used in an engine is to be recommended when gas or electricity is not available and where the amount of water to be pumped is small, as the fuel cost is usually high The advantage of this power is that, as a usual thing, the pumping unit can be started and operated at full capacity in a few minutes, ten minutes being a fair average. The objections are much the same as previously stated for gas, but there is the additional disadvantage of hauling and storage of the fuel and dangers of explosions in or near the buildings.

(e) Crude oil engines are rapidly being perfected and placed on the market which materially reduce the fuel cost, but require a little more time to start up than either the gas or gasoline engine.

(f) Electricity is very nearly an ideal power for this service, provided that an attractive rate can be obtained and the service is reliable for twenty-four hours each day.

A combination of any of the above powers may be used to advantage, depending upon the demands of the particular case.

(7) Accessibility by the attendant in charge materially affects the selection of equipment and cost of operation. If the amount of water to be pumped is only moderate, plant difficult of access, and electricity is available, it is desirable to keep cost of attention to a minimum; therefore make plant as nearly automatic as possible.

The location of the booster station depends entirely on local conditions. All things being equal, it should be located at the main reservoir from which the supply is taken. It is also preferable to have the pump so located that water will flow to it by gravity from the main reservoir. This insures the pump being primed at all times and eliminates the danger of getting air into the line.

When the section to be supplied is so situated that it is inadvisable to locate the booster pump at the reservoir, it should be located on a prominent main at a level which will positively assure a good supply on the level of pump intake.

A large vacuum chamber as well as an air chamber should be used on reciprocating pumps and a large air chamber would show good results even with a centrifugal or rotary pump.

In locating the booster plant attention should be given to the discharge. It is always preferably to use an independent line from pump to booster reservoir. Pulsations and noises are easily felt on lines from which service is given. Pulsations can be very materially reduced by the use of a large air chamber, depending entirely on the type

* Abstract of paper and discussion before the Central States Waterworks Association, September, 1912.

† Vice-President and Chief Engineer, Harris Pump Supply Co., Pittsburg, Penn

and apacity of the pump and the velocity of water in the line. Greater efficiency can be obtained from this air chamber if air can be supplied to the chamber to increase the relative proportion of air to water.

Noises can be reduced by the use of special gaskets or lead nipples. In some very bad cases it can be cured by using a short section of hose in the discharge between the pumps and the discharge main.

In both of these respects the advantage of using an elevated tank or standpipe or hydro-pneumatic pressure tank near the pump is very evident.

Third.—The third class of service is where the regular line pressure is sufficient for domestic consumption, but insufficient for proper fire protection to fulfil the requirements of the company's charter. The method of treatment, however, would be so nearly the same as for the second class that no additional suggestions will be given for this class.

Since the cost of attendance is one of the chief items of operating expense in a plant it is very desirable to reduce this expense to a minimum.

If an attendant is required all the time the pump is in operation it is generally good practice to install equipment of large capacity to reduce this item of expense. This means, however larger mains and larger storage capacity.

It would, therefore, seem desirable to keep line and reservoir cost down by pumping much of the day at a lower rate per hour, leaving only enough reserve to take care of ordinary increase in consumption or falling off of pump capacity and giving ample time for ordinary repairs. To do this and still keep down cost of attendance requires apparatus as nearly automatic as possible.

With steam equipment, an attendant is necessary on account of the use of boiler, but if steam is taken from some other source so that the pump is the only part requiring attention, then it should be the aim to provide a reliable source of lubrication and control speed of pump automatically. The simplest control is by a pressure regulator where the difference between starting and stopping pressures is fully 10 per cent. of the supplying pressure in the line and exclusive of the friction head. Where the line is a long one and the pump comes up to speed very rapidly it will be noticed that the pressure required to accelerate the water in the line from its state of rest to its regular velocity momentarily runs the pressure far above the maximum or stopping pressure of the system. Ordinarily this would cause the automatic control to act and stop the pump, and, this pressure being only temporary, the pump would again start, and the result would be a rapid alternation of stops and starts. This can be overcome by the use of a tank, of about 50 gal. capacity, to which pressure connection is attached. This connection should be made from discharge main to tank, so that the rate of flow from one to the other would be very small, namely, 1 or 2 gal. per min.; then with sufficient air compressed in top of tank so that it is ordinarily half full of water: it will be noticed that the pressure is very slow to respond to changes in the main line pressure and the temporary pressure due to starting is passed, and normal is restored before the tank shows any appreciable change.

Where the increase of pressure due to accelerating water in the line is high enough to endanger the pump or other equipment, a relief or safety valve should be installed to take care of the excessive pressure.

Where the difference in pressure between starting and stopping is less than 10 per cent., most regulators are unreliable, due to back lash and lost motion in the springs and other mechanisms. In such cases an artificial head can be produced, which, if the flow of water from the pump were constant, would cause sufficient difference in pressure to cause the controlling mechanism to operate, I believe, within 2½ per cent. of the shutting off pressure.

If this were carried out by the use of the tank described above and the introduction of sufficient friction in the discharge of pump to the discharge main, it would with regular line friction make the necessary difference required. This plan could not be successfully used with centrifugal pumps due to the varying capacity of pump under different conditions. In any case the power required for pumping would be increased by approximately the same amount as the increased pressure; still this amount would be very small compared with the saving effected.

The automatic control of steam pumps by float from the surface of the water in the reservoir is so complicated that circumstances would seldom justify it.

Electric pumps are by all means the easiest to operate automatically, first because an electric pump can be provided to operate continuously with practically no attention; and second, because electricity can be transmitted so easily. Stopping and starting can be easily performed by the rise and fall of water in a reservoir several miles away by means of a float and solenoid switches.

Pressure control is, however, always preferable, as the controlling apparatus is then under the same roof with the pump and the motor, and the danger from ice, storms, etc., which exists with floats, chains, etc., is eliminated.

Gas or engine automatic control is difficult, owing chiefly to the fact that most engines have to be started by some external power, and this is difficult to accomplish from a remote point. Partial operation, however, may be obtained by keeping the engine in continuous control, properly governed and well lubricated, and with an automatic pressure regulator, pressure being taken as previously described. This regulator would operate a control attached to level of a friction cut-off coupling so that the pump would, therefore, be started and stopped as desired. Float control would also be difficult by this method.

Another method of patrial control would be by connecting up the ignition circuit of the engine with a presure regulation or with a float switch. Then the engine could be stopped when the reservoir was filled, but could be started again only by an attendant. In this case a magneto should be used instead of batteries, for when the pressure fell to the starting point, it might short-circuit the batteries and run them down.

Discussion.—C. B. Salmon, of Beloit, Wis., said that experience with two or three booster installations, one at a mine in West Virginia had shown the electrical centrifugal pump to be easy to operate and very effective.

L. A. Tonkel, of Alliance, Ohio, gave substantially the following account of a booster station in his city:—

Our main pumping station is located about 240 ft. lower than the highest point in Alliance, and there have been days and days when everybody was sprinkling in extreme dry weather when the people at the highest point could not get any more than 10 lbs. pressure, although we had 240 lbs. pressure at the plant. The question arose of how to relieve that condition, which had existed for twenty years until people were getting tired of it. This hill was the finest location and best residence portion of Alliance, and they wanted water in those fine homes. I suggested years ago that we lay a 12-in. or 14-in. line from the town up to Mount Union, and put in a separate pump and pump to them direct just the same is if we were supplying two separate towns; that we have one pump for that hill and another for Alliance proper; but we found that would cost the city $300,000, and that was thought to be too much. So, instead of doing that, last spring we installed a booster pump just half way between the lowest point and the highest point.

At our lowest point we carry 125 to 130 lbs. at the pump house.

I start the pump at the booster station by electricity at 5 a.m., and at 7.30 p.m. it is shut down. I have a 12-in. valve between the inlet of this pump and the outlet. That gives them water in case of fire over night. When I start the booster pump I shut that valve off. When we get through with our improvements we are going to have two standpipes, one 60 ft. high, to supply the low pressure, and another one 100 ft. high, to supply the high pressure. When the standpipe is full on the high-pressure line the pump will shut itself down, and stay shut until we use 20 ft. After that the pump will start automatically. That is the way we have ours arranged. We ran it for one month for 3c. per kw.-hr.

Several who discussed the paper spoke favorably of electrically-driven pumps.

In response to numerous suggestions and requests Mr. Cole promised to supplement his paper with figures of costs and other data which would assist waterworks superintendents in deciding on the advantages of using booster pumps and aid them in choosing the best plan to meet local conditions.

RAILROAD EXPENDITURE WILL BE HEAVY

President E. J. Chamberlin, speaking of construction work on the Grand Trunk Pacific Railway, says the problem from now on to completion will be wholly one of labor. "We expect to have the line in operation for through traffic by the beginning of 1915. It is just a question of getting the requisite amount of labor into the territory in which we are building; it is simply a matter of displacing so many million tons of earth and getting enough men to do it expeditiously. At present we have about 10,000 men at work."

This year the Canadian Northern Railway will construct 978 miles of road to complete the Transcontinental line. This mileage includes 350 miles from the summit of the Rockies to Lytton, B.C., and 300 miles along the north shore of Lake Superior.

Work will be commenced by the Canadian Northern Railway between Toronto and Hamilton during the spring. The right of way between Hamilton and Niagara Falls is being secured.

The company hopes to finish the road from Toronto to Niagara at the same time as the Canadian Northern Railway transcontinental. Provision for through connection with New York, via an American line, and bridge connection at Niagara Falls, remains to be made.

Satisfactory headway is being made in completing the line between Toronto and Ottawa.

The line between Ottawa and Montreal will be ready next spring, and early summer should see a Canadian Northern Railway passenger service between Toronto and Montreal.

The Canadian Pacific Railway will shortly commence work on a four track system between Brandon and Fort William.

Forty million dollars will be expended in Montreal by the railways within the next two or three years. This large outlay is being undertaken by the Canadian Northern, the Grand Trunk, and the Canadian Pacific Railways, with the Canadian Northern assuming over half the expenditure. With the formal acceptance of the plans for the tunnelling of the mountain, the Canadian Northern Railway expect to commence operations early in the spring upon this task.

The Grand Trunk Railway expect to spend between $9,000,000 and $10,000,000 in the elevation of their tracks and in the building of a new station at Montreal.

The Canadian Pacific will apply for an act authorizing it to construct six new lines and extending time for completion of five others, already authorized.

It will also incorporate the Quebec, Portland and International Short Line, from La Patrie South to the International Boundary, following North River to Newport, Vt., to the main central in Eaton. This is supposed to be part of the plan for shortening the distance between Montreal and Portland over Main Central.

A new railway project is announced through application to incorporate the All Red Line Railway, from the Eastern boundary of the Province of Quebec westerly to Winnipeg, with branches to Ottawa, Port Arthur and Fort William.

CHANGES IN ONTARIO PUBLIC HEALTH ACT.

The important changes in public health legislation brought about by the new Public Health Act, as well as their likely effect on general conditions, in the estimation of Dr. J. W. McCullough, Provincial Medical Health Officer, are as follows:—

The supervision of sanitary conditions in the province by district officers of health (Sec. 13). Under this system the individual municipality will receive closer attention and first-hand advice from the district officers.

Local boards of health are retained, but the number of members reduced, and the medical officer of health is made a member—and the executive officer—of the board. Members of township boards are to receive $2 for each meeting attended. (Sec. 14-21). The medical officer of health, a qualified medical practitioner, to be appointed at a reasonable salary by the municipal council, and cannot be dismissed except for cause and with consent of the provincial board. He shall attend the annual conference of health officers and his expenses shall be borne by the municipality. (Sec. 35).

The work of local boards will, it is generally felt, be carried on in the better interests of public health, since the M.O.H. is a member, and since members in townships will be remunerated for attendance at meetings. By making the M.O.H. a permanent officer and paying him a reasonable salary, his services to the municipality will become more valuable, and interest in his duties will be still further increased by his association with officers in the same work at the annual conference each year.

Municipalities shall contract for the medical care of indigent sick (Sec. 52), and the M.O.H. may inspect lodging houses, etc., and if he deems a building unfit for human habitation, may placard it. (Sec. 86). The effect of these provisions will be obviously a step towards improved social conditions.

But the most important, owing to its far-reaching effects, is the legislation relating to waterworks and sewerage systems. Plans for the establishment and extension of any such system must be approved by the provincial board before any debentures can be issued to raise money for these purposes. In this way, the requirements of the board—as to proper treatment and disposal of the sewage, and the source of supply and process of purification of the water—must be carried out. The board may direct as to the maintenance, repairs and improvements of such system; and upon a certificate of necessity from the board, work may be undertaken in the interest of public health without a vote of the ratepayers. (Sec. 89-98). The final effect of this will mean the lessening of the pollution of our waterways, a safe supply of drinking water, and consequently a reduction in the number of cases of death from typhoid fever and other water-borne diseases.

WORKMEN'S COMPENSATION

BY C. W. I. WOODLAND.

While we have a so-called Workmen's Compensation for Injuries Act in force in Ontario, in reality it is not a compensation but rather an employers' liability act. There is a vast difference between the two. The term workmen's compensation as applied to the Ontario Act is a misnomer. In view of the wrong impression conveyed by the title, the employer of labor as a rule looks to the company in which he is insured for a great deal more than what his policy or contract calls for, and what he pays for. The employer pays for protection or to be indemnified "against loss from the liability imposed by law" upon him. He insures for his own benefit, and not for the benefit of his employees. Workmen's compensation insurance is a different proposition altogether. It is a form of accident insurance that calls for the payment to the injured workman of certain indemnities irrespective of how the accident occurred or who was to blame.

Under an up-to-date workmen's compensation law such defences as contributory negligence, common employment, assumption of risk, etc., etc., are done away with, and, subject to certain provisions and limitations, would entitle the injured employee, or in case of death his dependants, to compensation; the only proof of claim necessary being the fact that the employee met with an injury arising out of and in the course of his employment.

Under such a form of legislation the cost of insurance would be fixed by the insurance company commensurate with the obligations imposed upon the employer, and as the scale of indemnities would be provided for in the Act all the insurance company has to do is to make payments accordingly. This is an ideal condition and one that, provided the Act is carefully framed, practically does away with litigation, and from a humanitarian standpoint should meet with the cordial approbation of both employer and employee.

As I have already pointed out, in the province of Ontario to-day there is no such thing as a real workmen's compensation law. Under the present laws, the employer may not be held liable for accidents happening to his employees if

1. It can be shown that the accident was caused by contributory negligence on the part of the injured employee.
2. The accident was caused by a fellow-servant or workman in like employment.
3. The accident was incident to the injured man's employment and one over which he alone had control.

These are only a few defences to an action for damages. There are many others. Suffice it to say that when an employer delegates to a liability company his responsibility, or legal position, as it were, in respect to accidents happening to his employees, it is for the insurance company to decide whether to allow compensation or defend an action for damages, for and in the name of the employer, at the insurance company's expense. The employer pays a premium for indemnity against his legal liability only. He pays nothing for what is termed his moral liability. The insurance is for his protection and not for the benefit of his employees.

A workmen's compensation act, on the other hand, is for the benefit of the employees, and such being the case the employer would have to pay more for his insurance than under present conditions, but no doubt would cheerfully pay the extra premium knowing that his moral as well as his legal obligations would be as cheerfully cared for.

The tendency under present conditions is for the employer to expect a little more, and sometimes a great deal more than what he pays for. It often happens that when an employee is injured the humanitarian and generous employer sends the injured employee to the hospital, guarantees the payment of hospital, doctors', and nurses' bills, and pays the injured employee's wages during the period of his disability—this aside from the conditions of insurance—and then expects the liability company to reimburse him for his outlay, even though it may subsequently have to defend an action for damages brought by the employee.

The old stock argument of the policyholder who assumes the functions of the insurance company upon his own responsibility, notwithstanding the fact that the contract or policy expressly stipulates that

> "The assured shall not voluntarily assume any liability, nor shall the assured, without the written consent of the corporation previously given, incur any expense or settle any claim except at his own cost, etc., etc."

is that "it pays better to settle than to have to fight a lawsuit," overlooks the fact that his is not the only case the liability company is dealing with, and that thousands of claims are constantly in the course of adjustment.

It will be a progressive move when the province of Ontario adopts an up-to-date workmen's compensation for injuries act. The cost for insurance would then necessarily be more than it is to-day. The insurance company carrying a risk would have something definite to go by in the matter of paying compensation. Litigation would be a thing of the past, and instead of the iniquitous, or I should say the ubiquitous, lawyer getting his share of the spoils as he does to-day, the full indemnity would be paid direct to the injured employee. Until this new order of things comes about the employer of labor carrying liability insurance should recognize the difference in conditions and keep in view the fact that the insurance he is now carrying is for his protection, and not in any sense of the word for the benefit of his employees.

PAPER MANUFACTURING IN CANADA.

Canada has certainly made strides during the past year or so in paper manufacturing. Mr. E. B. Biggar, of Toronto, a Toronto pulp and paper authority, says that Canada's growth of the two industries has exceeded that of any single nation in the world since wood became a raw material for paper making. A remarkable feature of this development has been the number and capacity of the new mills devoted to news-print, these mills representing the last word in mill designing, in capacity of paper machines and in rapidity of production. The following is a list of these news-print paper mills:—

	Daily capacity in tons of paper.
Powell River Company, B.C.	200
Dryden Timber and Power Company, Ont.	40
Spanish River Pulp and Paper Mills, Ontario	155
Ontario Pulp and Paper Company, Sturgeon Falls, Ont.	45
Sault Ste. Marie Mill, Ontario	200
International Falls Mill, Fort Frances, Ont.	100
Ontario Paper Company, Thorold	120
Price Brothers and Company, Jonqueires, Que.	150
Edwin Crabtree and Sons, Quebec	20
Smaller new mills and additions to old mills, say	170
	1,200

Thus there has been an increase of 1,200 tons per day in news-print. It is not strictly correct to say that this is the work of a calendar year, for some of these new mills were

started in the latter part of 1911, while two of them are not yet finished and will not be in operation till the middle of 1913, but the increase which can be credited to 1912 will still be about a thousand tons per day.

STORES OF VANCOUVER ISLAND

BY ERNEST McGAFFEY.

As it is axiomatical that cities thrive as the surrounding country develops, so it follows that the railway and trunk road policy inaugurated by Sir Richard McBride and the provincial government has been of vital importance to Vancouver Island. The Premier of British Columbia has stimulated development in these lines so greatly that it is no exaggeration to say that railways and roads head the list of the factors leading to progress all over the island.

The advent of the Canadian Northern Railway not only meant the opening up of large areas of virgin territory, but it carried with it an immediate stimulus to the halibut and whale fisheries, with important capitalization and extension of these industries. It also made accessible vast timber tracts, iron deposits, etc.

The aggressive activities of the Canadian Pacific Railway through its island line of the Esquimault and Nanaimo Railways promises to revolutionize conditions along the east coast of Vancouver Island, and particularly along that portion of it represented in the rich Comax and Courtenay country, a district not surpassed on the island for excellence as a dairying and mixed farming centre. The entry of this line into the Alberni Valley and to Alberni and Port Alberni was also of great importance, as opening up a magnificent timber belt, and connecting with the west coast by way of the Alberni Canal. Coal, copper, and fisheries are also tributary to the Alberni district, and general tourist traffic has been increased by this branch.

All along the Alberni Canal the various communities as Uchucklesit, Bamfield, Sechart, Ucluelet, Clayoquot, and other settlements, have felt the impetus afforded by the incoming of the Esquimault and Nanaimo Railway to the Alberni district.

Development along the line of the Esquimault and Nanaimo Railway from Victoria to Nanaimo is shown at every point. Probably the most apparent results are at Duncan, Ladysmith, and Nanaimo. At Duncan, in the Cowichan Valley, much progress has been made recently in this model farming community.

At Ladysmith, there are from 3,500 or 4,000 people, and its future as a manufacturing and shipping point is assured, with its fine natural harbor, rail facilities, and adjacent possibilities as a fruit-growing district.

Nanaimo is awakening to its possibilities. Its pay-roll runs into the hundreds of thousands from the near-by coal mines, large sawmilling interests and fisheries. Other interests include stone quarries, timber, fisheries, manufactures, and an adjoining district of splendid possibilities for mixed farming, truck gardening, fruit growing, poultry-raising and stock-farming, and fine shipping facilities. The city has now about ten to twelve thousand population, and is increasing rapidly in numbers.

Cumberland is also evidence of Vancouver Island's advancement, and with the Esquimault and Nanaimo Railway's extension, it will have connection with this line through the present railways running from Cumberland to Union Bay. As the central city of a coal-mining district, Cumberland will grow. Fine water-power on the Courtenay River and lumbering districts are near it.

Comox, Sidney, Courtenay, Chemainus, and other towns on the east coast, Port Alberni and Alberni show steady growth. Port Alberni is the terminus of the Esquimault and Nanaimo Railway, and Alberni is only two miles further inland. Both towns have good harbors; they will merge in time.

Victoria is one of the leading ports of the Dominion. Her new outer harbor, to be built by the Dominion government, requires an initial outlay of $1,500,000, and will take $10,000,000 to complete it and the inner harbor improvements.

Victoria's harbor is practically free from fog, and easy of access and departure. Freight and passenger traffic has doubled in the past three years; in 1911 over 5,500 vessels berthed in its harbors. It is the coming terminal of five transcontinental railway systems, viz., Canadian Pacific Railway, Canadian Northern Railway, Grand Trunk Pacific, and Great Northern and Great Eastern Railway. As a manufacturing, commercial and residential city, its future is bright, and its tributary territory contains valuable natural resources, including the following:—

A supply of merchantable timber equivalent to about a billion feet per year for a hundred years. Then there is 1,500,000 acres coal deposit controlled by one corporation. Iron is found at Sooke, Bugaboo Creek, Sarita, Nootka, Campbell River, Quatsino and other points.

Vancouver Island produced, according to the Tyee Copper Company manager's estimate, "about one-half of all the copper that has come from the entire Pacific coastal district during the five years ending April, 1910. There is five hundred thousand horse-power of water-power available, though present development is less than 50,000 horse-power

There is a supply of marble, brick clay, fire clay, gold and silver, quicksilver, talc, and various other metals and natural products, sand, gravel and building materials.

There are two cement plants, one fully equipped and running, and the other soon to be ready.

Agriculture, horticulture, fruit and berry growing, poultry-raising and live-stock breeding are profitable and being developed.

Valuable fisheries are also among the island's resources; whale fishing is carried on at Sechart and Kyuquot, controlled by Messrs. Mackenzie and Mann. Salmon is abundant. Halibut is caught in large quantities on the west coast. At Nanaimo the large herring industry is under the control of Japanese.

BIG ORDER FOR RAILWAY EQUIPMENT.

The past year was an unusually busy one for the rail mills, locomotive works and car foundries. The Canadian Pacific, Grand Trunk, Grand Trunk Pacific and Canadian Northern Railways gave orders during 1912 for 727 new locomotives and 43,164 freight cars. These orders will keep the car and foundry companies busy well into the current year. The figures may be summarized as follows:—

Engines or cars ordered, 1912.	Canadian Pacific Railway.	Grand Trunk Railway.	Canadian Northern Railway.
Passenger	414	.....	150
Freight	29,442	7,650	6,072
Miscellaneous	194	.....	.....
Total	30,524	7,790	6,336
Locomotives	473	140	114

It is estimated that there were at least 20,000 more cars and 400 more locomotives available last fall than in the previous year.

The Canadian railways expended last season about $4,000,000 on improvements and enlargements of terminals.

COEFFICIENT OF SLIDING FRICTION OF CONCRETE ON CONCRETE.*

By Frank P. McKibben.†

In well designed masonry structures reliance is placed on something besides friction to resist sliding tendencies; but unfortunately not all structures can be classed in the above category, and a knowledge of the value of frictional resistance is necessary. In concrete or stone masonry dams, both in the structure itself and at the base, the horizontal pressure should be resisted not by friction alone but by shearing. Clearly this can be accomplished by bonding the masonry—stepping it at the base and interlocking in the body. However, to provide against errors in construction every structure in which there is a tendency to slide on any plane must be proportioned to have a proper factor of safety against sliding on that plane.

The importance of this precaution is only too well illustrated in several recorded failures of masonry structures. It is further emphasized by the fact that in an ordinary masonry dam with a vertical upstream face and a curved downstream face, designed to keep the line of resistance just within the middle third, the factor of safety against sliding on horizontal planes, considering friction only, is about 1.1 to 1.5 at most. And this condition obtains where no upward pressure is assumed to act at these planes. When the upward pressure acts the factors on the same cross-section are less because the resultant normal pressures are less, while the tangential components remain unchanged.

If, as is sometimes the case through lack of supervision, such a dam be built with horizontal joints or with a horizontal base, the factor of safety is altogether too small. The question of what coefficients of sliding friction the above factors of 1.1 to 1.5 are based upon is then a very pertinent one.

A search of experimental data on the frictional resistance of masonry reveals the fact that as far as can be determined all tests have been made on separately moulded specimens, and practically nothing has been done toward determining the resistance of concrete to sliding on concrete with the upper body moulded directly on the lower. If two cubes of concrete be separately made and then superposed for testing, the resistance to motion can be called the friction of starting and the resistance during motion the friction of motion; but if one cube be moulded directly on another and later tested in that position the resistance to sliding is at first due to adhesion, and during motion the resistance is, of course, friction of motion. All published friction coefficients are seemingly those of bodies without adhesion.

It further appears that the coefficients of friction frequently recommended for masonry structures, namely, from 0.60 to 0.75, are those at which sliding actually starts—not the coefficients modified by a factor of safety but the actual values which cause the motion to begin. Assuming that the coefficient necessary just to start motion of concrete on concrete separately moulded is 0.66, and that a dam is built with that same relation existing between the horizontal sliding force and the resultant vertical component on the horizontal joint, then but one factor of safety against sliding exists at that joint, if the surfaces between the experimental blocks are the same as those in the dam and adhesion in the latter is neglected. A factor of one really means no factor at all; it means that the structure is just on the point of moving. If, on account of the upper mass of concrete in the dam being laid directly on the lower, adhesion is considered, then the factor of safety in the above hypothetical case is probably greater than one, possibly 1.5 or 2. The coefficient of friction must be considered an ultimate or breaking coefficient, and clearly the working factor should be considerably less than this. Its value should be found from the breaking coefficient by dividing the latter by a real factor of safety.

The only experimental determinations of frictional resistance of stone are those of Morin, made between 1813 and 1834, and of Trautwine. Morin's experiments were made on dry blocks of soft oölitic limestone sliding on the same material, the contact areas varying from 0.5 sq. ft. to 0.86 sq. ft., with total normal pressures ranging from 310 to 1,275 lb. For this material he gives 0.74 and 0.64 for co-efficients of friction starting and of maintaining motion respectively. Trautwine made a few experiments, but none of them was on concrete. The coefficient of friction for masonry is therefore based on stone, and nothing has been published regarding concrete.

Recently in the Fritz Laboratory some experiments were made by Messrs. S. C. Peters and I. A. St. John, and the following is a summary of the work accomplished up to the present time:—

Some 12-in. concrete cubes were separately moulded in wooden forms, and, after curing, the coefficients of sliding friction were determined by placing one cube upon another and finding the force necessary to slide the upper along the lower. The accompanying table shows details of the tests for low normal pressures.

The apparatus used in testing consisted of a bell-crank lever, the vertical arm of which was connected by a horizontal yoke to the upper cube. On the horizontal arm of the bell-crank was a vessel into which fine shot was carefully poured till motion took place. The forces determined in this manner, together with the pull due to the weight of the bell-crank, are those necessary to start the upper cubes. As the total motion of the cube was only a few inches no distinction could be made between the starting forces and those necessary to maintain motion. In some tests the normal force was increased by adding standard 50-lb. weights on the upper cube.

Results of Tests to Determine the Coefficient of Sliding Friction of Concrete on Concrete.

No. of Tests.	Total weight moved, lb.	Total pulling force, lb.	Friction coefficient per cent.	Condition of surface
	Mixture, 1:2:4 Concrete.			
1 to 6	146.35	105.72	72.2	Dry
7 to 14	147.81	101.09	68.4	Wet
15 to 20	148.75	99.26	66.7a	Dry
	Mixture, 1:3:6 Concrete.			
22 to 25	147.5	101.11	68.6a	Dry
26 to 28	147.5	100.05	67.8	Wet
29	197.5	140.63	71.2a	Dry
30	197.5	114.27	57.9	"
31 to 32	197.5	138.61	70.0	"
33 to 34	247.5	175.63	70.9a	"
35	297.5	176.63	59.4a	"
36	347.5	237.95	68.4a	"
37	397.5	251.27	63.2a	"
38	447.5	296.27	66.2a	"
39	497.5	321.63	64.6a	"
40	547.5	366.27	66.9a	"
41	597.5	377.95	63.3a	"
42	647.5	395.27	61.0	
43	697.5	423.27	60.7	

Average coefficient 29-43 65.6. Average of all tests, 67.7.
a Indicates surface cleaned.

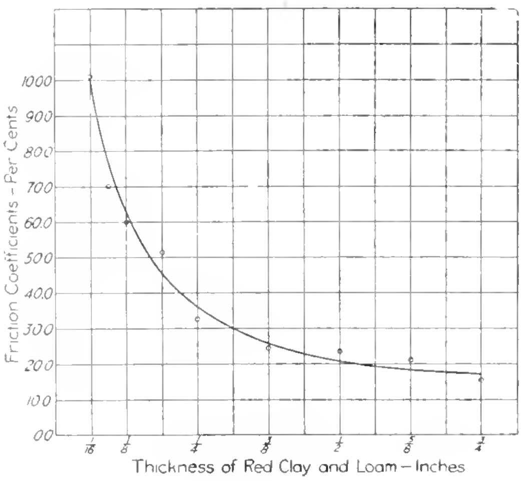
---

* Abstract of paper delivered before National Association of Cement Users.

† Professor of Civil Engineering, Lehigh Valley

The average coefficient of all tests shown in the table is 67.7 per cent. There is no great difference between the values obtained for 1:2:4 and 1:3:6 concrete; but the former are slightly larger. Wetting the contact surface seems to lower the coefficients but very little. In tests numbered 29 and 30 the average coefficients are 71.2 and 57.9 per cent. respectively; the conditions in the two series being the same except that in the first the contact surfaces were cleaned after each test by removing the dust formed by grinding while in the latter the dust was allowed to remain. A similar effect was shown in other tests. From test 33 to test 43 the total weight moved was gradually increased from 247.5 to 697.5 lb., and this was accompanied by a decrease in the coefficient from 70.5 to 60.7 per cent. Since the surfaces were cleaned after each test this decrease was probably due to greater smoothness caused by rubbing and not to any change in coefficient resulting from increased pressures, except in so far as the increased pressures may increase the abrasion.

Another interesting test, though not conclusive, because it was only one test, was performed by moulding one cube directly on another that had previously hardened. After allowing the two to set for 20 days the sliding test was made



Curve of Friction Coefficient.

with the result that a total pulling force of 200.95 lb. was necessary to slide the upper cube, weighing 147 lb. In this case the adhesion caused the coefficient to reach 37 per cent. More tests of this character are now under consideration, as are some to determine the effect of laitance.

Of interest also is a set of experiments to find the coefficient of two cubes between which was placed a ¾-in. layer of wet red clay and loam. From this thickness the layer was gradually diminished till it reached about 1/16 in., the coefficient being found at each thickness. The accompanying curve showing thickness of clay and corresponding coefficients indicates that with a ¾-in. layer the coefficient was 15.3 per cent., while for the thinnest layer the coefficient was 101.0 per cent.

As all of the 42 tests recorded in the table were made on separately moulded cubes superposed on each other in pairs, the conclusion reached for this case is that for ordinary concrete the average coefficient for sliding friction is 67.7 per cent., corresponding to an angle of friction of about 34 deg. The minimum value obtained was 57.9 per cent. and the maximum was 79.4 per cent. It should be remembered that the values here given are those which cause motion and before being used in design should have a proper factor of safety applied to them. A determination of the effect of moulding concrete in contact, of the presence of laitance, and of increased normal pressures will throw further light on this question of frictional resistance.

SMOKE PREVENTION WORK IN CHICAGO.

The city of Chicago has for a number of years through its Smoke Department given considerable study to proper furnace design with reference to smoke production and has achieved much success through advising plant owners as to advisable furnace changes. The department has realized, however, that the smoke ordinance as interpreted was not elastic enough to take in all classes of offenders, and it, therefore, instituted in the spring of 1912 an investigation involving a great many chart readings to be used in comparing different plants in the same industry. An appeal could thus be made to the civic pride of the owners of plants which, even if not violating the law, were nevertheless producing large quantities of smoke. The plan was described by Mr. Osborn Monnett, smoke inspector, before the Western Society of Engineers, Nov. 4, 1912.

The ordinance, Mr. Monnett pointed out, says that only dense smoke constitutes a violation. Dense smoke, according to the Ringlemann method of reading, is No. 3 smoke or worse. If a plant makes a continuous No. 2 smoke the total amount of smoke made in a 10-hour run would be enormous, yet the plant would easily run within the smoke ordinance and the matter could not be taken into court.

The smoke density of a plant running a continuous No. 2 smoke on the Ringlemann chart would be 40 per cent., yet another stack might violate the smoke ordinance in seven minutes of continuous dense smoke, and be absolutely clear for the rest of the hour or the rest of the day, and the smoke density for the day would not figure more than 2 or 3 per cent., yet the second offender would be liable to prosecution while the first offender, who was really making the most smoke, would go entirely free.

According to the technical interpretation, the Ringlemann chart reading consists in reading the smoke density of a stack every 15 seconds for the period under observation; in this way a very close record of the behavior of the stack is obtained. The method of figuring the data on a chart of this kind is as follows. The number of observations of Nos 1, 2, 3, 4 and 5 smoke are tabulated and reduced to smoke units as follows:

70 units of No. 1 smoke =	70
34 units of No. 2 smoke =	68
100 units of No. 3 smoke =	300
29 units of No. 4 smoke =	116
146 units of No. 5 smoke =	730
Total	1,284

As the readings were taken every 15 seconds, this figure 1,284 divided by 4 gives the smoke units on a per minute basis, and as one smoke unit represents a density of 20 per cent., the calculation for the per cent. of density for the stack would be

$$321 \times 0.20 \times 100 \div 170 = 37.7 \text{ per cent.}$$

170 in this case being the number of minutes the stack was under observation.

The Ringlemann chart reading shows not only the per cent. density of the smoke for the day, which is in fact the measure of the desirability or undesirability of the stack, but it also gives the number of violations per hour of the stack, if any. Readings of this nature taken in the past 6 months have been classified according to industries and charted for closer study. A standard of 2 per cent. density for a day's observation was taken to represent good performance, anything under 2 per cent. being considered exceptionally good and anything above 2 per cent. being considered subject to criticism. This is entirely independent and separate of any consideration of whether or not a stack actually violated the ordinance.

The method of making use of the tabulated information is as follows: In working on, for instance, the clubs of the city, a copy of the chart is shown to the offender at the foot of the list and an appeal to his civic pride is made, which in most cases is sufficient to get satisfactory action.

In approaching an industry such as a piano factory for instance, which is making too much smoke, the department first picks out a factory in the same line of business which has as nearly as possible the same boiler equipment and lays the facts before the offending corporation, in effect, for instance, that whereas their piano factory is running, say, 18 per cent. or 19 per cent. smoke density on a day's observation, the piano factory across the street, a competitor of theirs, is running inside of 0.5 of 1 per cent. density, and that from the smoke department's standpoint there is no reason why their piano factory cannot be run as clean as another piano factory, provided they will put their plant in proper shape. This argument seldom fails to get the desired results without suit or threat of suit.

The information contained in the tabulated list is of great value, Mr. Monnett stated, in combating claims of plant owners when they make the assertion that their plants do not smoke. One of the most common statements made to the department is that the owners do not believe the plant is smoking and that, compared with a similar line of industry, their stack is much better than their competitors. In one instance a brewery manager made this statement, and if it had not been for the tabulated information on file it would have been very difficult to convince this party that he was not right. When this manager realized that of 44 breweries in the city, 35 or 36 of them were making less smoke than he was, he capitulated, and in the near future his entire boiler plant will be rebuilt in the effort to get to the top of the list.

The smoke department is holding every new plant built in the city of Chicago to a standard of 2 per cent. smoke density on 10 hours' observation before issuing a Certificate of Operation, as provided for in the ordinance. That this standard is not unreasonable, even in the hand-fired installations, may be realized when it is stated that with approximately 250 new plants which have been installed under permit since Jan. 1, 1912, practically all of them that have been put in operation are able to show this low density on a Ringlemann chart. Those which do not show this density are studied with a view to improving conditions, and no Certificate of operation is issued until this standard is reached. For the purpose of keeping track of this work, a form of Certificate of Operation Release has been prepared. This certificate, after giving the type of boiler and furnace, provides for a statement by the engineer of the district that he has personally seen the furnaces in operation, carrying their regular working load, and that he knows personally that the plant can be operated inside the ordinance. To this form is attached a Ringlemann chart reading showing a day's operation with 2 per cent. density or less; the certificate is then issued, a copy of the Ringlemann chart going to the plant owner with a statement that this is the standard which the smoke department will expect the plant to maintain in the future. As the Ringlemann chart is taken with the full knowledge of the operators, it really sets a mark for them to maintain, and any deviation from it is quickly noticed by the smoke department and followed up until the plant is clean at all times.

The same plan of using the good performance of one company to spur others to better work is being pursued in the railroad campaign. In the fall of 1910, series of railroad readings were made showing the smoke conditions at the various railroad centres, and a table showing the smoke standing of the railroads was prepared. In the fall of 1911 a similar set of figures was prepared. It soon became evident that there was an intense rivalry among the various railroads in their efforts to be at the top of the list. This has been taken advantage of with good effect by the smoke department. It has long been realized that railroad smoke appeared heavier in summer than during the cold weather, but it was not known how much the weather affected smoke densities. Taking the smoke readings of the fall of 1911 as a criterion, and assuming the same effort on the part of the railroads to keep down smoke, the summer readings of 1912 show that there is approximately 100 per cent. difference in the smoke density in the summer over the winter months.

The railroad readings are furnished in more detail than has been presented before, as it has been found that the more information the department can convey to the railroads the better the results. For instance, by giving the smoke densities for the various locations, a railroad may find that its per cent. density at a certain point is very satisfactory, whereas at another railroad centre it is not at all satisfactory. By analyzing these smoke density reports for the various localities, a railroad is enabled to determine the points where their engines need special attention and to discover why it is that they cannot have a uniform smoke density throughout the city. Theoretically, if one railroad is inside of 5 per cent. density there is no reason why all the rest of them should not be, but practically it does not seem to work out in this way; there is a difference in organization, difference in methods, difference in service performed, and difference in condition of equipment, which seem to have an immense amount of influence on the smoke densities of the various roads. However, it seems logical, Mr. Monnett believes, that if uniform methods of enforcing the anti-smoke rules were adopted by all the roads, and if standard equipment in various classes of service was provided, that uniform results can be obtained throughout the city and the smoke kept down to the minimum.

MUST INSTALL BRICK PLANTS

Lessees of Western clay lands in future must make bricks as well as stock sales. An order-in-council has been issued regarding the leasing and administration of lands containing limestone, granite, slate, marble, gypsum, marl, gravel, sand or any building stone, in the provinces of Manitoba, Saskatchewan and Alberta, and the Northwest Territories; within twenty miles on either side of the main line of the Canadian Pacific Railway in the province of British Columbia, and in the tract of three and one-half million acres acquired by the Government of the Dominion from the province of British Columbia. The order amends the existing regulation so as to include the leasing of Dominion lands containing deposits of clay, subject, however, to the following additional conditions:—

1. The lessee of a clay location shall, within two years from the date of the lease, erect upon the lands described therein, or on lands acceptable to the Minister, a plant suitable for the manufacture of brick or other clay products, and he shall, within the same period, furnish evidence, supported by affidavit, showing the character and value of the plant installed and the date of its installation. If the required plant is not installed within the time specified, and if evidence of its installation is not furnished within the same time, the lease shall be subject to cancellation in the discretion of the Minister. Provided, however, that the Minister shall not require that the value of the plant so installed shall exceed the sum of $10,000.

2. The lessee of a city location shall, during each year of the term of the lease after the second year, manufacture

from his leasehold and produce ready for shipment not less than 100,000 bricks, or their equivalent in some other form of clay products, to the satisfaction of the Minister. If during any year, after the second year of the term of the lease, the lessee fails to furnish satisfactory evidence of his having done so, the lease shall be subject to immediate cancellation in the discretion of the Minister.

UNITED STATES STEEL CORPORATION IN CANADA

The fact that the United States Steel Corporation has for several years been acquiring real estate at Sandwich, Ontario, led to the theory that at some time or another that corporation would establish a plant there. The time has apparently arrived, as, according to a dispatch from New York at a meeting of the directors of the United States Steel Corporation it was decided to build a new plant at Sandwich, costing approximately $20,000,000, to manufacture practically all classes of steel. The company has about 1,500 acres of land, with 1½ miles of waterfront opposite Detroit, Michigan. The corporation will probably erect a number of blast furnaces in addition to wire, rail, structural and bar mills. Tinplate and tube works may also be erected. All the details have not yet been arranged but it is likely that a bond issue to meet part of the cost of construction of the new plant will be negotiated. No date has been set for the beginning of construction, but work will probably be started as soon as all arrangements have been made. To operate the plant, a new subsidiary of the United States Steel Corporation will be organized in Canada.

Mr. J. H. Plummer, president of the Dominion Steel Corporation, discussing the above announcement, said:—

"There is room for us all in Canada, and it is certainly better from the general standpoint that the trade should be in the hands of strong people. The Dominion Steel Corporation is not afraid of competition from the United States Steel Trust or anybody else."

Mr. J. R. Wilson, a Montreal director of the Dominion Steel Corporation, and also identified with the Canadian Steel Foundries, said: "One may draw his own conclusions as regards competition. For instance, in the buying of ore the Dominion Steel Company pays about $1.75 per ton, while the United States Company pay $3 to $4 for the same, and yet the United States company, with their vast knowledge, experience and money, can and are selling their finished product at $5 per ton lower than any other company, even at the recent advance of steel prices.

"Though I believe the United States Steel Corporation will do us no material harm, it is true there will be a great deal sharper competition immediately the plant begins to operate at Sandwich. Any competition will be felt largely in the West, where the country is growing and the demand is large, but in the East I do not believe the competition will be felt for the present."

In the annual number of The Monetary Times, published this week, Mr. Thomas Cantley, of the Nova Scotia Steel and Coal Company, complains of the extent to which Canada was utilized last year as a dumping market, illustrated by the fact that of the entire export of pig iron by the United States in 1912, 90 per cent. was thrown into Canada, while of finished products an enormous tonnage was disposed of in the same market at prices in many instances 20 to 25 per cent. below that at which they were selling raw pig iron five years previously.

Canadian steel manufacturers are anticipating early revision of the tariff. Any changes made will be announced in the budget speech which is not due, however, for several months yet. Mr. Cantley says that notwithstanding the enormous home demand, coupled with good trade and high prices in Great Britain, Germany and other European countries, owing to the ill judged action of the United States producers last year and the inadequate customs tariff applying to a considerable percentage of steel products imported from the United States, Canadian mills and forges find their earnings much less than they should have been under normal conditions.

Sandwich, where the United States Steel Corporation will establish its Canadian plant, is the capital of Essex County, Ontario, on the Detroit River. About two miles northeast of the town is Windsor, the terminus of the great western division of the Grand Trunk Railway. The town is on the line of the Sandwich, Windsor and Amherstburg Electric Railway and has a population of approximately 2,300.

LAST YEAR'S GOLD PRODUCTION

The world's production of gold during 1912 was $5,500,000 greater than in 1911, the total having been $465,000,000, according to a preliminary estimate of Mr. George E. Roberts, director of the United States mint. Gold production in the United States amounted to $91,685,168, compared with $96,890,000 in 1911. California led with $19,988,486; Colorado was second with $18,791,710; Alaska third with $17,398,946; Nevada fourth with $13,331,680, and South Dakota fifth with $7,795,680.

Of the world's production the Transvaal and Rhodesia made a gain of about $20,000,000, and Canada gained nearly $3,000,000. The United States, Mexico and Australasia lost about $16,000,000, and in the rest of the world the production was about what it was last year. Since 1908, when the production of gold in the world was $442,475,000, the annual increase has been comparatively small.

The mint service of the United States during the year sold $38,000,000 worth of gold bars for consumption in the arts in this country and Canada, as against $35,000,000 in 1911. The net consumption of new gold, including coin for such uses, in the United States and Canada was about $35,000,000, and in the world, excluding Asia, probably between $100,000,000 and $115,000,000.

The absorption of gold by India, which has been attracting attention for several years, was again a noteworthy feature. The net imports of India in 1909 were approximately $50,000,000; in 1910, $90,000,000; in 1911, $116,000,000, and in 1912 approximately $140,000,000. The movement of silver to India also continues to be very heavy. The importations of silver, in ounces, during 1912 have been exceeded only once in the history of India in 1906.

The increase of gold in the monetary stock of the United States in 1912 was approximately $90,000,000. The gold holdings of the United States Treasury increased about $70,000,000, chiefly in bullion, represented in the circulation by certificates.

The production of silver in the United States during 1912 amounted to 62,369,974 fine ounces compared with 60,399,400 fine ounces in 1911, the chief gains in production having been made in Utah and Colorado. Nevada ranked first in production with 13,042,118 fine ounces, Utah second with 12,795,072 ounces, Montana third with 12,338,589 ounces, Colorado fourth with 8,350,316 ounces, and Idaho fifth with 7,703,121 ounces.

There is talk of double tracking the Temiskaming and Northern Ontario Railway.

NEW COMPANIES IN ENGINEERING AND OPERATING FIELDS.

The new White companies held their organizing meetings on January 6th, and announced the following boards of directors and officers:—

Of The J. G. White Engineering Corporation the directors are: Harry Bronner, of Hallgarten & Company; James Brown, of Brown Brothers & Company; F. Q. Brown, of Redmond & Company; Douglas Campbell, of Campbell, Harding & Pratt; Geo. C. Clark, Jr., of Clark, Dodge & Company; Bayard Dominick, Jr., of Dominick & Dominick; A. G. Hodenpyl, of Hodenpyl, Hardy & Company; T. W. Lamont, of J. P. Morgan & Company; Capt. Marion McMillan, of Emerson McMillan & Company; J. H. Pardee, president The J. G. White Management Corporation; E. N. Potter, of Potter, Choate & Prentice; Frederick H. Reed, vice-president J. G. White & Cómpany, Inc.; Chas. H. Sabin, vice-president Guaranty Trust Company; Frederic Strauss, of J. & W. Seligman & Company; Moses Taylor, of Kean, Taylor & Company; George H. Walbridge, of Bonbright & Company; E. N. Chilson, and C. E. Bailey. And the officers are J. G. White, chairman finance committee; Gano Dunn, president; E. G. Williams, A. S. Crane, H. A. Lardner, vice-presidents; H. S. Collette, secretary, and R. B. Marchant, treasurer.

During the year ending October 1, 1912, the departments of J. G. White & Company, Inc., which have just been organized into the above engineering company, were at work on contracts aggregating in cost over $28,000,000, and on appraisals and reports upon properties aggregating over $400,000,000. Many different types of engineering service were required throughout thirty different States and Canada, among them the complete rehabilitation of several public service properties, the construction and equipment of two high-speed interurban electric railways, one of which is eighty-four miles long and includes difficult tunnel and canyon construction in California. There was also engineering for the drainage of 118,000 acres in Florida, and the design and construction of a 124-mile 12-inch natural gas pipe line, which line is noteworthy because it is the first in California, and because it is to operate at a pressure of 450 pounds per square inch, the highest ever yet employed.

The hydro-electric developments include some of the most important in the United States, such as the Big Sandy, at the foot of Mount Hood in Oregon; the Deerfield, an important tributary of the Connecticut River; the Savannah River development near Augusta, Georgia; the Broad River near Columbia, South Carolina, and the Ocoee in the mountains of eastern Tennessee. In addition to these, there are the San Joaquin development in California, and that of the Beauharnois, on the Saint Lawrence in Canada. The aggregate capacity of these water powers is approximately 366,000 horse-power.

The J. G. White Management Corporation announces as directors Cecil Barret, of Spencer Trask & Company; F. Q. Brown, of Redmond & Company; P. M. Chandler, of Chandler Brothers & Company, Philadelphia; Arthur Coppell, of Maitland, Coppell & Company; Gano Dunn, president The J. G. White Engineering Corporation; George E. Hardy, of Hodenpyl, Hardy & Company; R. G. Hutchins, Jr., vice-president National Bank of Commerce; R. L. Montgomery, of Montgomery, Clothier & Tyler, Philadelphia; John T. Pratt, of Campbell, Harding & Pratt; Frederick Strauss, of J. & W. Seligman & Company; H. R. Tobey, of N. W. Halsey & Company, and J. G. White, president J. G. White & Company, Inc. And the officers are: J. H. Pardee, president; F. H. Reed and S. L. Selden, vice-presidents, and T. W. Moffat, secretary and treasurer.

The business of the Management Company was established some years ago as a department to supervise the operation of properties in which J. G. White & Company, Inc., was interested. This department, which has now been formed into a separate company, was, on December 31, 1912, acting as Operating or Consulting Operating Manager of public utility and railroad properties in the United States, Nicaragua and the Philippine Islands, including The Manila Electric Railroad & Lighting Corporation and subsidiaries; The Helena (Montana) Light & Railway Company, the Eastern Pennsylvania Railways Company, of Pottsville, Pa., and subsidiaries; the United Light & Railways Company and subsidiaries; the Associated Gas & Electric Company and subsidiaries; the Augusta-Aiken (Georgia) Railway and Electric Corporation and subsidiaries; Pacific Railroad of Nicaragua; Kentucky Public Service Company and subsidiaries; and other properties.

The parent organization, J. G. White & Company, Inc., controls the new companies and will continue as an active financing and owning company.

THE PORT OF PARA, BRAZIL.

The port of Para, Brazil, is described in the October, 1912, "Bulletin" of the Pan-American Union. Para is on the Para River, which belongs to the Amazon system, though not on the main outlet to the largest river bearing that name. It was established as a town as far back as 1700, and has taken its place as the largest rubber shipping port of the district. In 1910 the vessels entering the port of Para numbered 1,969 steamers and 1,668 sailing vessels with a total tonnage of nearly 1,500,000 tons. The opening of the Madeira-Mamoré Railway promises to add considerably to the use of the port. In November, 1907, work was begun on a system of docks with accessory appliances, which provide permanent facilities for the present traffic of the city of Para, as well as for the traffic present and to come from that immense area known as the Amazon Valley, and although addition must later on be made to the docks as they exist now, yet the unit of improvement has been established and further expense should be nothing more than a duplication of that unit. The work is being carried on under an American corporation holding its concessions from the federal government of Brazil. To it is given a monopoly of the port services, construction, and operation of quays, warehouses, and other works at Para within a zone of 18 miles toward the ocean and 12 miles in the other direction, for a period of 65 years, and this period is to extend to 90 years after the completion of the second section of the work. The main channel to the port has a depth of 30 ft., and a total width of about 400 ft. between channel-line buoys. This leads up to the dock, which consists of about one mile of quay wall for ocean-going steamers where there is a depth of 30 ft. at low water of ordinary spring tides. In addition, there is 722 ft. of quay wall for river steamers with a depth of water of 12 and 1,500 ft. of quay wall for still smaller river steamers with a depth of water of 9 ft. 6 in. The quay walls are built of large concrete blocks. Back of the quay is a well-paved platform or roadway on which are warehouses and freight handling machinery. Beyond the warehouses on the city side of the port works proper is a newly finished road about a mile long and 60 ft. broad, making both a boulevard and, with the trees which are being planted, a future park. In addition to the port works proper, the company is building a ship repairing depot with floating drydocks and necessary shops.

COAST TO COAST.

Niagara Falls, Ont.—A by-law to raise $3,000 for increased fire-fighting apparatus carried at the recent election. The by-law to bonus the Vermont Marble Company to the extent of $5,000 was defeated. The money is now being raised by private subscription.

Province of Alberta.—Mr. Charles Mohr, a civil engineer of Seattle, Wash., after an extended trip through northern Alberta, is endeavoring to interest Alberta municipal authorities into the possibilities of the asphalt deposits of this territory. In his estimation the civic authorities should take immediate steps to secure the mineral rights on these resources and then work them jointly.

Transcona, Man.—The second unit in connection with the large Grand Trunk Pacific shops and yards at Transcona, near Winnipeg, has recently been completed. The cost of the first and second units is $500,000, and they include car works foundries, locomotive roundhouses, and 110 miles of trackage in the yards. The shops are among the best on the continent, and all the G.T.P. freight from Western Canada will be handled at the yards there.

Vancouver, B.C.—The Minister of Public Works has received the report of Edward White, the British landscape artist engaged to suggest the location of new departmental buildings on Wellington Street in this city. The report is understood to be the direct opposite of what was proposed by Frederick Todd, of Montreal. The latter favored seven or eight buildings. Mr. White would group the structures and have them fewer in number. The government will decide which plan is preferable and then will likely ask for competition designs.

Prince Albert, Sask.—A report with reference to the civic administration and city development of Prince Albert is being made by Messrs. E. A. James and T. Aird Murray, of Toronto. The report will be made at the first meeting of the city council this year, will deal with the duties of the works commissioner and city engineer, and will incorporate certain suggestions regarding streets, park system, types of suitable pavements, railroad crossings, sewage and water supply, etc.

Ottawa, Ont.—The Ottawa city council have decided to engage two British experts, Sir Alexander Binnie, of London, Eng., water engineer, and Dr. Houston, scientific adviser to the Metropolitan Water Board of London, Eng., to report upon the best supply of pure water for this city. The arrangements for the engaging of the experts were made through Lord Strathcona, high commissioner for Canada, at the request of Premier Borden and Mayor Ellis. Sir Alexander Binnie and Dr. Houston were recommended by Rt. Hon. John Burns, president of the local government board in the Asquith ministry.

Toronto, Ont.—Works Commissioner Harris, in a report to the city council, states that the slow sand filtration plant finished last year for the city supply of water, leaks from five to six million gallons a day. The leakage into the clear water reservoir is nearly 3,000,000 gallons per 24 hours. A special meeting of the Board of Control will discuss the question of obtaining an independent expert's report on the whole question. The results of the test by Commissioner Harris do not coincide with the evidence as given before Judge Winchester at the recent investigation. It was stated then that the total leakage was not over 500,000 gallons a day.

Montreal, Que.—Plans are being prepared in Montreal for a structure, 56 by 75 feet, ten stories in height, to be erected next spring for the Bank of British North America at Edmonton, Alta. The cost of the building, which will occupy a double corner at Jasper Avenue and First Street, is placed at $1,000,000. It is given out that separate tenders will be called in Montreal and Edmonton within six weeks. The building will be steel and brick with ornamental stone facings and is to be fireproof throughout. The entire ground floor will be used by the bank, a portion of it being reserved as residence quarters for members of the bank staff. The rest of the building will be used as offices.

Saskatoon, Sask.—Following the announcement of the the selection of a site for the hospital buildings in connection with the University of Saskatchewan several of the daily papers have given publicity to a report which stated that the site was too low to provide suitable drainage into the present sewerage system without the expenditure of much money. It is learned that provision has been made, however, to have the design of the new traffic bridge, that is to be erected by the provincial government, altered in such a manner that the drainage from the hospital site may be carried over and connected with the intercepting sewer at 25th Street. The civic power cables will also be strung beneath this bridge.

Province of Ontario.—The Hydro-Electric Power Commission of Ontario, Continental Life Building, Toronto, propose some time before the end of January, to call for tenders for the various materials necessary in connection with the construction of approximately 125 miles of double circuit transmission line at 110,000 volts and the necessary equipment for sub-stations for the transforming of 20,000 h.p. from the line to 13,200 volts. Various types of apparatus will be considered; for instance, the different materials for conductors and different types of steel construction for supports. As mentioned above, specifications will be issued about January 15th, and the tenders will be called for in March.

Montreal, P.Q.—The city garbengers will take no more waste picture films to the incinerator in the west end of Montreal. A few days ago an explosion followed the throwing into the large oven of a quantity of the celluloid subsubstance which contains guncotton in its ingredients. The picture films which were sent to be destroyed by one of the picture show establishments of Montreal, were regarded as ordinary garbage. This has been done before but the films were in smaller quantities and nothing was thought of the little puff and the report which followed. But this time a genuine explosion occurred, which set fire to the building. The electric light connections were also burned out. The fire was quickly under control, and Superintendent Chenevert informed the board that the total loss was only about $15.

Sandwich, Ont.—A new steel plant costing over $20,000,000 which will turn out practically all classes of steel is to be built shortly at Sandwich Ont., by the United States Steel Corporation on a property of 1,500 acres with a water frontage of one and a half miles opposite Detroit which it has owned for several years. It is understood that the plant will be built and operated by the Steel Corporation. The present intention is to build a wire mill, rail mill, bar mill and possibly several others. To operate the plant a new subsidiary of the United Steel Corporation will be organized in the Dominion. The corporation's business with Canada in the past has ranged from 350,000 to 400,000 tons annually, representing from $12,000,000 to $15,000,000. The average duty on its sales has been between $6 and $7 per ton. It is expected that a considerable part of the products of this plant will be marketed throughout the Empire.

Edmonton, Alta.—A ten-story building at a cost of $250,000 is being erected at First and May Streets, to be known at the Royal Alexandra Hotel. The foundation has been completed and six stories will be erected in 1913, four floors being added in 1914. The plans, prepared by Messrs. Van

Siclen and Macomber, of Edmonton, show an exterior in renaissance of the latter French period. The first two stories are to be faced with white sandstone, the upper floors being in terra cotta finished with sandstone. The side walls will be of brick, the mansard roof of slate. The main entrance to the rotunda is to be panelled in Canadian marble, the floor being laid in the same material. An elaborately wrought iron marquee will be erected over the main entrance. The rotunda will be spacious, with Canadian marble columns and Honduras mahogany, the panels being so set in as to provide space for trophies and game heads. The upholstering will be in leather, of a design corresponding with the rest of the scheme. There will be 20 rooms on each floor, all having outside light and ventilation, each room being fitted up with a shower bath and other conveniences, including telephones and the latest built-in features. The structure is fireproof throughout, while the staircases and elevator are so arranged that they can be utilized to the greatest measure to give aid in the event of fire.

WHEELER TURBO-AIR PUMP.

The Wheeler Condenser & Engineering Co., Carteret, N.J., announce that they have acquired the American license to build turbo-air pumps of the A. E. G. Type as manufactured in Europe by the Allgemeine Electricitaets Gesellschaft. This air pump is of the rotary water jet type, for motor or steam turbine drive, air being removed from the condenser by ejector action of a series of small water jets and also by positive entrapment of air between successive small slugs of water. A number of these pumps are now under construction at the works of the Wheeler Condenser & Engineering Company, Carteret, N.J.

CHANGING A C. P. R. BRIDGE.

The Canadian Pacific Railroad bridge across the St. Rose River, Canada, had several 160-ft. spans with pin-connected Phœnix trusses, spaced about 20 ft. apart on centres. They were recently replaced by a double line of 80-ft single-track deck-plate girder spans, supported on the old piers and on new ones built between them. The new super-structure was erected and the old superstructure removed without interfering with traffic and without the use of falsework.

The tops of the old piers were cut down to the required elevation to receive the new girders, and the old trusses were transferred to bearings on timber crib-work built to maintain them at the required elevation. The new girders of the Canadian Pacific Railway Company's standard type, weighing about 49 tons per span, were delivered on pairs of flat cars, run across the old bridge to the required positions, unloaded by derrick cars and suspended by tackles hung from transverse beams supported on the top chords of the trusses. The flat cars were released and removed and the floor system quickly removed, allowing the new girders to be lowered to bearings on the old and new piers.

After all of the new girders for one line of single-track spans had thus been erected, the old spans, weighing about 120 tons each, were supported from them and taken down by the derrick cars, after which the deck spans were shifted transversely to their required positions. The girders for the parallel line of single-track spans were delivered on them and erected in position by the derrick cars.

The plate girder spans were fabricated and erected by the Dominion Bridge Company, Montreal, in accordance with the requirements of the Canadian Pacific Railway Company. Mr. P. B. Motley, engineer of bridges, was in charge of the work.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

At the meeting of Section D, Engineering, on Friday, January 3rd, a programme of thirty papers devoted to highway engineering and related subjects occupied the morning and afternoon sessions. The titles of the papers and authors have been published in a previous issue of this journal. The sessions were presided over by Professor Arthur H. Blanchard as chairman and Professor George W. Bissell as secretary.

On Saturday, January 4th, many of the engineers in attendance visited the plant of the Deckman-Duty Company, at which Dunn wire-cut-lug paving brick are manufactured. The inspection trip of the morning, which was made with automobiles also included the examination of various sections of brick and stone block pavements in Cleveland. The tour of inspection was made through the courtesy of Mr. F. B. Dunn and the officials of the Deckman-Duty Company and the National Paving Brick Manufacturers' Association, who, on the preceding evening, entertained many of the engineers present at a dinner given at the Cleveland Athletic Club.

CANADIAN CLAY PRODUCTS MANUFACTURERS' ASSOCIATION.

The annual convention of the Canadian Clay Products Manufacturers' Association is being held in Toronto this week. The association are still pursuing their efforts to secure the establishment of a course in Ceramics in connection with the Faculty of Applied Science and Engineering of the University of Toronto Mr. C. W. Raymond, of the Raymond Brick Machine Company, Dayton, Ohio, in a letter to the association, agreed to give full equipment necessary for the work of such a department, provided one were established. A joint committee, composed of members of the association, members of the Faculty of Applied Science, and representatives of the Engineering Alumni Association, will approach the Board of Governors of the University at an early date to impress upon them the desirability of the founding of such a department.

PERSONAL.

J. O. MOUSSEAU, the member of the Quebec Provincial Parliament for Soulanges, has been appointed to the new provincial portfolio as Minister of Good Roads.

SIR ALEXANDER BINNIE, consulting engineer for London, England, and Dr. Houston, of the Metropolitan Water Board, of London, have been asked to report on the water supply of Ottawa.

D. F. McLEOD, superintendent of public works at Ithaca, N.Y., has been appointed city engineer of New Glasgow, N.S., to take effect after the expiration on February 28 of his present contract with the city of Ithaca.

FRANK C. ASKWITH is at present acting city engineer of Ottawa. He has been attached to the city engineer's department of Ottawa for the past five years, and before that had several years' experience on railroad construction in the West.

N. J. KERR, until recently city engineer of Ottawa, has accepted a position with the Canadian Pacific Railway. He succeeds Mr. N. J. Carry, who resigned on account of poor health, in charge of Shaughnessy Heights, at North Vancouver.

HAROLD PARKER, M. Am. Soc. C.E., first vice-president, Hassam Paving Company, Worcester, Mass., on

January 10th delivered an illustrated lecture on "Specifications Covering Patented Pavements," before the graduate students in Highway Engineering at Columbia University.

LEE MURRAY has been appointed to the seat on the board of directors of Bruce Peebles & Company, Limited, Edinburgh, Scotland, recently vacated by Mr. Chas H. McKuen. Mr. S. E. Bastow and Mr. J. H. Bunting have been appointed joint managers in the place of Mr. Murray, who has retired from the position of general manager of the company.

COMING MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Meeting of Mining Section will be held on Thursday, Jan. 16th, at 8.15 p.m., at the Society's Headquarters, 413 Dorchester Street West, Montreal. Sec'y, C. H. McLeod.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Third regular meeting of the Toronto Section will be held at the Engineers' Club, 96 King Street West, at 8 p.m., Friday Evening, January 17th, 1913. "Notes on the construction of Toronto Hydro-Electric System." Mr. J. G. Jackson; "Practicability of the Toronto Street Lighting System," Mr. W. R. Sweeney; papers illustrated with stereopticon views. Secretary, H. T. Case, 611 Continental Life Building, Toronto.

THE CLEVELAND ENGINEERING SOCIETY.—Informal meeting, Chamber of Commerce Building, January 21st, 1913. "The Practical Illumination of Factory Buildings (Illustrated)," by Ward Harrison, Illuminating Engineer, The National Electric Lamp Association. Secretary, David Gaehr.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W. Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St., Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre: Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Jan. 23, 1913 Contents of this issue on page 211

The Canadian Engineer

An Engineering Weekly

WATER-POWER FROM THE MISSISSIPPI.

The Large Hydro-Electric Development in the Centre of the United States.

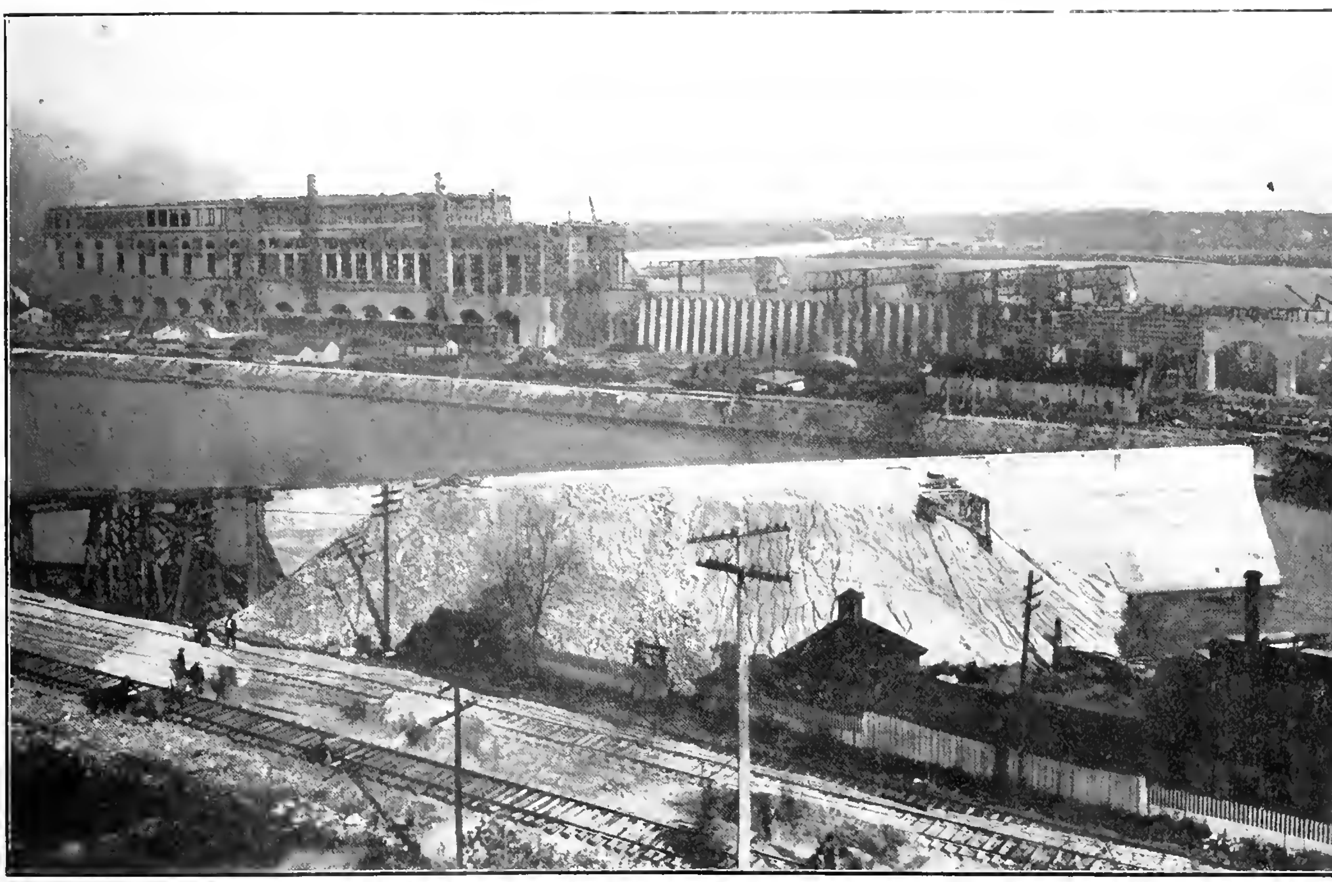
BY G. DONALD DELL

The notable things in the water-power development in the Mississippi River are three: the location; the size of the plant, and the solution of some engineering problems involved.

The location is in the centre of the Mississippi Valley with its large supply of raw materials for factories and its large consumption of manufactured products—and there are no other large water-power sites near this one.

The development at the foot of the Des Moines Rapids in the Mississippi yields over 300,000 horse-power on the turbine shafts. It consists of a dam 4,649 feet long, including the abutments at either end, a power house 1,718 feet long, a large lock with a lift of 40 feet, and a large dry dock, besides appurtenant structures rendered necessary by the conditions found there.

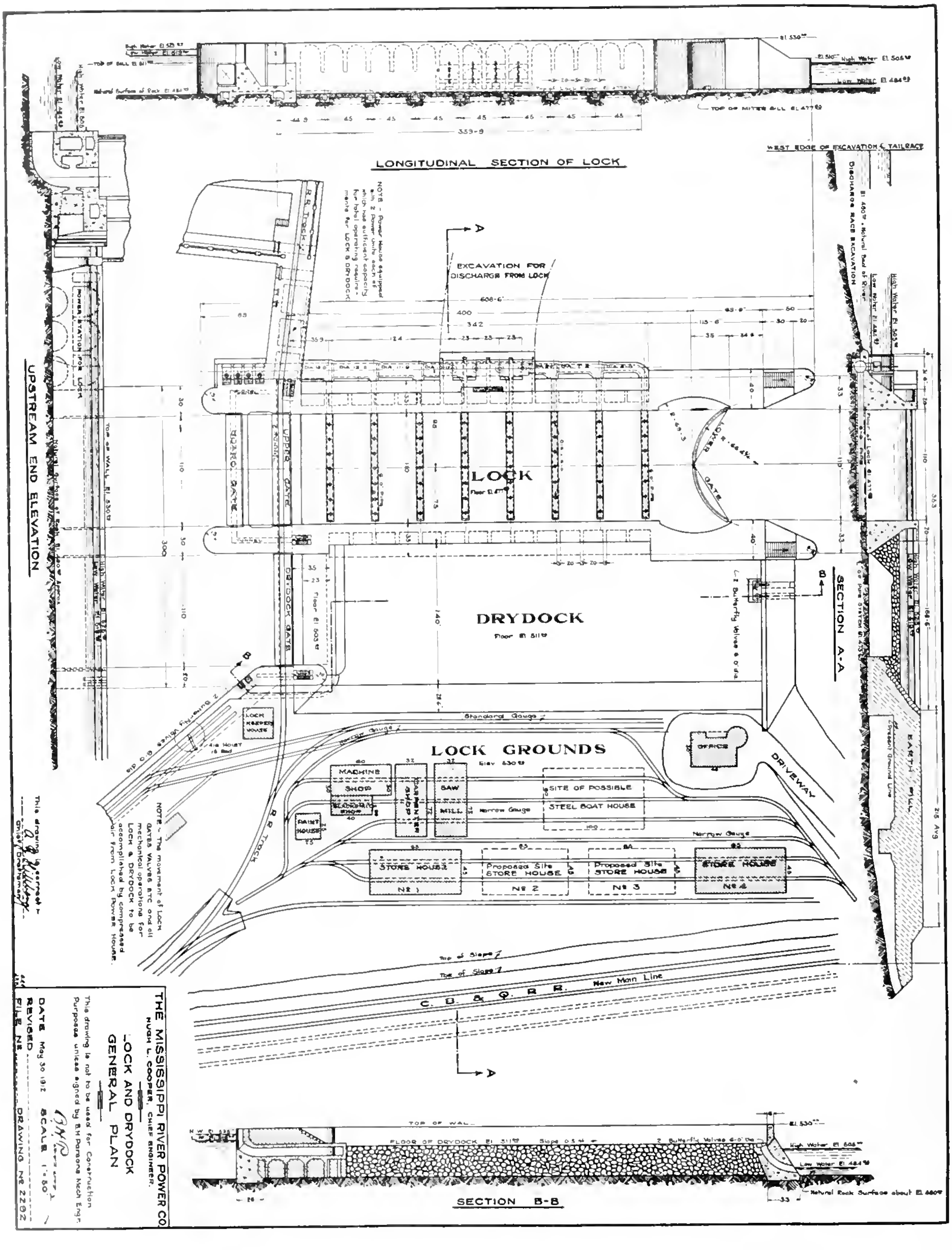
Considerations of river flow prescribed by the United States government regulating navigation, of storage, and of constant head, determined the plan of the dam. It consists of 119 arched spans with 30-foot spaces between 6-foot piers; in each span is a spillway topped by a steel gate. The dam is gravity section, massive concrete with each one of the 119 sections capable of withstanding all stresses upon it without reference to any other part of the structure. At first glance, the dam strongly suggests a bridge, and reduced to its lowest



Part of Forebay Side of Power House, Showing Arch in Front of Each Unit. Behind the Arches are the Pilasters Carrying the Strainers and Separating the Four Intakes to each Turbine.

mechanical terms it is a bridge with spillways between the piers. The spillway portion is 4,278 feet long; the east abutment is 290 feet long, and the west abutment 81 feet long, the latter being integral with the substructure of the power house. The dam structure is 29 feet wide on top and 42 feet wide at the bottom, which is set several feet into the

line of the arch of the span. They are trusses faced with 3/8 inch steel plates and will be operated with a traveling crane running on the top of the dam. The down-stream bearing surface of each slot is faced with an iron plate. When the final installation is completed the surface of the pool will be a little below the tops of the 119 gates, and conditions of



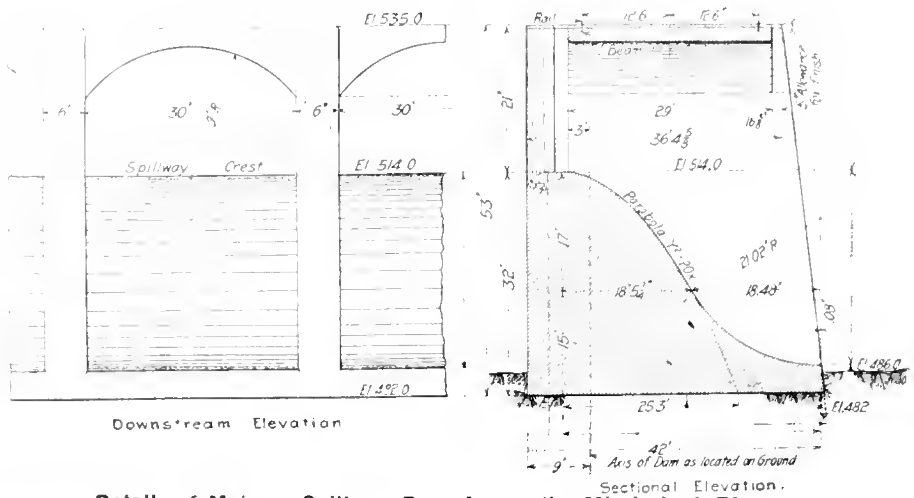
hard limestone bed of the river; the height of the structure is 53 feet and the spillways are 32 feet high.

Each spillway has a vertical up-stream face; the down-stream face of the spillways is an ogee curve. The steel gate on top of each spillway is 32 feet long, working in slots in the piers, and is 11 feet high, reaching to the springing

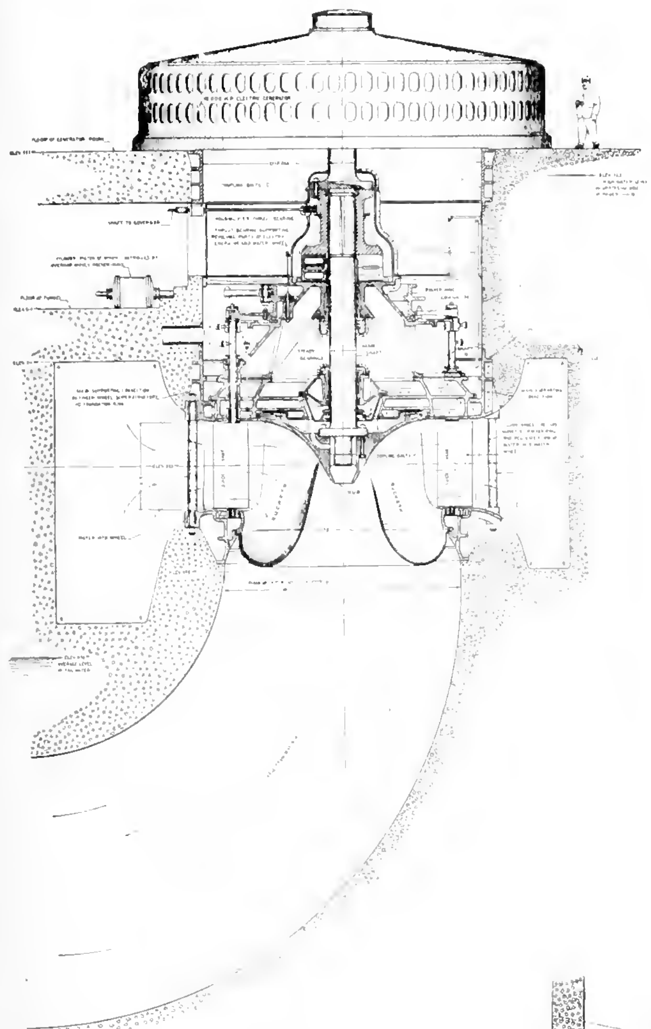
river stages and flow will govern the number of gates open at any one time

In building the dam, a thorough examination was made of its foundation. The river bottom at the side is blue limestone of rather remarkable homogeneity considering the distance involved. The bottom was unwatered by a cofferdam

several hundred feet long built ahead of the progress of the concrete dam itself, section by section as the work advanced. In this cofferdam section was made the excavation to key the dam into the bed-rock. Holes 4 inches in diameter and 30 feet deep were drilled to test for seams and pockets of softer material. Tests of these drill holes were made in three ways: They were dried and carefully inspected later for any moisture; they were put under air pressure after being sealed at the top and the attached gauge examined for any loss of air; the penetration of the drill as an ordinate to time was carefully platted and a regular curve required. The failure of the test hole to withstand these severe tests was cause for special excavation and investigation, although this was practically not necessary in the entire length of the dam.



Details of Main or Spillway Dam Across the Mississippi River.

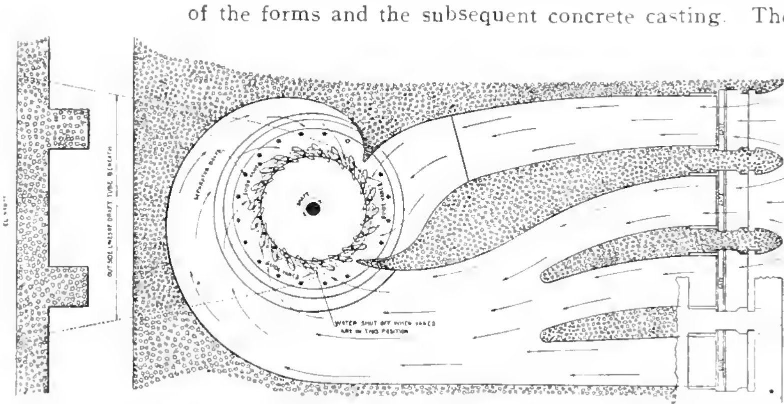


Centre Section of Main Turbine on Transverse Axis of Power House.

Steel forms were used in casting the dam, eight being in use at one time and the rear-most being constantly moved to the front, so that there was no delay on account of the concrete workmen waiting on the form riggers. The parts of each form were made interchangeable with the others. In the bottom member of each pier-form were two holes to fit over two dowel pins projecting from castings set in small concrete piers. There was a main frame for each up-stream and for each down-stream leg of the forms of each pier, and it was in the bottoms of these that

Part of Scroll Case with Turbine Installed, Surrounded by Guide-vanes.

the sockets fit the dowels in the base plates. By careful instrument work, these base plates were accurately located in alignment. After that, the members of the forms and their connecting bolts and stay bolts controlled the alignment of the forms and the subsequent concrete casting. The arch



Plan Showing Method of Conducting Feed Water from Head Bay to Guide-vanes in Front of Runners.

forms were hinged and arranged to be removed after the concrete set without wedges, blocking, or shores. The mixing plant was placed to deliver in the axis of the dam at the eastern end. Three standard gauge railroad tracks on top of the dam carried the concrete from the mixers in one and a half-yard buckets to the forms at the end of the dam in process of construction. There was a cantilever traveler with its cantilever arm 150 feet long extending out over the forms, which picked up the buckets from the cars and dumped them in place. This cantilever traveling crane had a main frame 25 feet by 90 feet, mounted on six heavy steel wheels which ran on a track of 25-foot gauge and 100-pound rails, spanning the three tracks used for hauling the concrete. This cantilever traveler, after its work on this dam was done, was sold to a Canadian company for use on the St. Lawrence.

Junction of the Dam and the Power House, Showing Some Spillways on Top of which go the Steel Gates.

The spillways were built with side dump cars pouring the concrete into conveyers which carried to the forms below, after the main structure of the dam was completed. Temperature variation of volume inducing cracking was provided against by strips of tar paper inserted in every pier and arch.

The power house is set near the Iowa shore almost parallel with the river, with the forebay between it and the Iowa bank, a curve in the river increasing the width of the upper end of the forebay. The substructure, 132 feet 10 inches by 1,718 feet and 70 feet high, was set about 25 feet into the river bottom, the tail race being excavated to the same depth on the eastern side of the power house. It is monolithic concrete in continuation of the dam at one end and the lock and other adjuncts at the other end. It was cast in wooden forms, an area of about thirty-five acres being unwatered in the river for the construction plant there. It contains thirty power units and four exciter-auxiliary units. Gantry cranes were used as concrete conveyers from the trains to the forms. Each turbine is placed in a scroll case 22 feet high and 39 feet in diameter, entered through four intakes so curved and choked as to deliver the water to the turbine runner with equal velocities at every point on the circumference of the wheel. The draft tube of each unit is circular, 18 feet in diameter at the top, and curves down into the tail-race, the lower end being an opening in the superstructure, two semicircles with tangent top and bottom, 22 feet 8 inches in vertical diameter and 40 feet 2 inches in horizontal width. The bottom of the draft tube is at the bottom of the tail race about 25 feet below the river bed. The water velocity at the upper end of the draft tube will be 14 feet per second, and at the exit 4 feet per second.

The turbine here presented the problem of a head of 32 feet with large volume of water and low rotation. As finally worked out, the answer is a turbine of original design, Francis type, of 57.7 r.p.m., efficiency of 86 per cent. by Holyoke test, and a little over 10,000 h.p. on the shaft. The runner has twenty buckets and weighs about 130,000 pounds, is 16 feet 6 inches in diameter and 11 feet 3 inches high. The shaft, with the turbine below and the revolving field of the generator above, is 25 inches in diameter. The weight is supported on one thrust bearing set high in the turbine pit, out of the water, and easily accessible, the top of a cone resting on the foundation ring of the pit liner. The latter is a steel cylinder imbedded in the concrete with rings at top and bottom weighing 100,000 pounds each. The weight on the thrust bearing is 550,000 pounds, and the lubrication is by forced oil with immersed roller bearing in reserve. It is believed that this installation has high dependability as well as satisfactory efficiency. The guide vanes of the regulator are connected to the compression cylinder by levers, rocker rings and cranks. Strainers are placed on buttresses projecting between intakes in front of which an arch for each unit marks the forebay side of the power house substructure.

The architecture of the superstructure is adapted to the electric machinery content, and the walls are of reinforced concrete and the roof trussed. The superstructure from generator floor to roof pinnacle is 107 feet 6 inches, making the total height of the power house 177 feet 6 inches from bottom of draft tubes to pinnacle.

The Lower Side of Part of the Power House, Showing Parts of Lower Ends of Draft Tubes with Exits into the Tail Race Excavated into the Bottom of the Mississippi.

The generators are rated at 9,000 k.v.a., 11,000 volts, three-phase, 25-cycle, with a full load efficiency of 96.3 per cent. and a regulation of 13 per cent. at unity power factor. Each armature is 30 feet 9 inches in diameter, and each gen-

erator weighs 614,000 pounds. Alternators, driven by turbines, supply current of 25 cycles at 4000 volts to three-phase busses running the length of the power house generator room, and from these busses is tapped off a 100 kw. generator set for each generator to excite the latter at 250 volts. The

The Keokuk Lock in the Mississippi During Erection of First Leaf of Lower Gates.

wiring of the electrical installation is worked out with some interesting novelties.

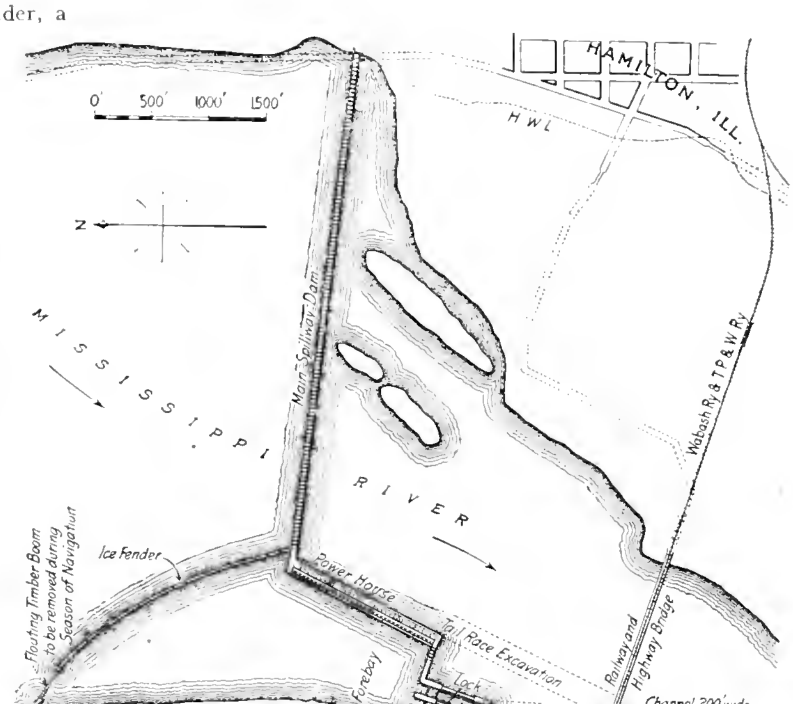
Swinging in a long curve from the western end of the dam across the entrance to the forebay is the ice fender, a concrete bridge with 10-foot piers and 60-foot spans, 8 feet wide at top and 16 feet wide at bottom, with its top 5 feet above high-water and the top of the span openings 4 feet below low-water. At the shore end is a floating boom of timber to permit steamboats to pass.

The shore side of the forebay is a sea-wall 1,100 feet long and 45 feet to 53 feet high, which protects the railway tracks elevated above the new water level above the dam. Fourteen miles of railroad had to be elevated and relocated along the pool.

The lock is at the lower end of the forebay, beside the dry dock, and is connected to the lower end of the power house substructure by a wall in which is placed the small turbines generating power to operate lock and dry dock through compressed air engines. The basin of the lock is 110 feet by 400 feet, and the lift is 40 feet with 8 feet over the sill of the upper gate. The conduit system comprises a main stem 13 feet in diameter under the east wall, with eight cross conduits 6 feet in diameter under the lock floor. In each cross-conduit are seven apertures, making a total of fifty-six openings for filling and emptying the lock chamber. Cylinder valves control the culvert system.

The lower gates are curved to R. 66 feet 4¾ inches inside and of 69 feet 3 inches outside. The versine is 10 feet 8½ inches. Their height is about 50 feet. Buoyancy chambers in the bottom are 12 feet by 31 feet 8 inches in dimensions. Each leaf has thirteen horizontal arched ribs 4 feet apart, connected by heavy girders and nine lines of intermediate framing. The railroad bridge steel, of which it is built, is tested to 65,000 to 70,000 per square inch. The pintles are of nickel-steel with bushings of bronze, and are hemispheres 18 inches in diameter. The mechanism by which these gates will be moved is the same as that at the Gatun locks on the isthmus of Panama, and it will be operated by a 40 h.p. compressed air engine.

The lock is 8 feet over the sill, in harmony with the 6-foot depth of channel being worked out by the government engineers between St. Paul and St. Louis, by order of Congress, with a factor-future of one-third added here. The upper gate of 110-foot span presented a problem which was solved with a gate of unique design. The lock gate and guard are raised to closed position and latched there by a buoyancy chamber, into which compressed air is pumped to replace water. To open the gate, water is allowed to enter the buoyancy chamber. The gate sinks beside the sill and the boat passes over it. Valves control the water and air inlets to the buoyancy chamber, and are themselves operated by compressed air. A rod running the length of the gate has a pinion on each end engaging a vertical rack, this device preventing jamming. Simplicity characterizes the design, and care was taken to make these upper gates "fool-proof," that is, dependable when operated by ordinary laborers. On top of the lock gate will be a standard railroad track, affording entrance to the power house from the railroad systems of the country, and the heaviest loaded freight cars may pass over the gate into the power house to be unloaded there by traveling cranes of 150-ton capacity installed there. Besides the lock gate and the guard gate, there is another gate to the adjoining dry dock chamber, and all three are built interchangeable. Should any gate need repairs, it will be floated, buoyant, into the dry dock, and if necessary, the guard gate may be temporarily used as either the lock gate or the dry dock basin gate. Each gate is easily and quickly removed by disconnecting it at both ends and floating it in the axis of the lock outside of its normal position, where the walls are re-



General Plan of the Dam and Power Plant of the Mississippi River Power Company, at Keokuk, Iowa.

cessed in a curve on each side, permitting the gate to be turned on its own centre and towed away. The dry dock basin is 140 feet wide and 463 feet long on the bottom, and

has a culvert system for filling and emptying it by gravity. It has sloping sides, and the dimensions at the top are 168 feet 6 inches by 468 feet over all. The grounds for machine shops, store house and other government buildings are extensive. This work, which is just beginning with the advent of 1913, requires a fill of 200,000 cubic yards.

The chief engineer of the work, all of which is done by administration, is Hugh L. Cooper, M. Am. Soc. C.E., who organized the Mississippi River Power Company, the proprietor of the water-power development there in which considerable British capital is invested. Mr. Cooper was attracted to the possibilities of the Mississippi development after finishing his labors on the plant of the Electrical Development Company at Niagara Falls, Ontario. He has a large and carefully planned organization on this Mississippi River work, which has progressed with remarkable speed and economy.

A NEW CANADIAN OIL-ENGINED SHIP.

An oil-engined vessel, the "Fordonian," has just been finished and has received her initial trials. The ship was built by the Clyde Shipbuilding and Engineering Company, Limited, of Port Glasgow, Scotland, and is the first vessel built on the Clyde propelled by two-stroke cycle Diesel oil-engines.

The leading dimensions of the ship are 250 ft. long, 42 ft. 6 in. beam, 16 ft. 10 in. moulded depth to the main deck, and 26 ft. 6 in. to the awning deck. The "Fordonian" has a 2-ft. frame pitch, and a dead-weight cargo-carrying capacity of 3,300 tons on 16 ft. 6 in. draught. The draught on service is restricted to 14 ft., and the dead-weight capacity is thus reduced to 2,200 tons. She is built to Lloyd's highest class for the Canadian Interlake Line, Limited, of Toronto, for grain-carrying on the Great Lakes of Canada. The vessel conforms to the standards of Canadian Lake practice in that she has a steering-pole out forward to make quite handy the control from the forward bridge, a large number of hatches, and inward opening cargo-doors on the port and starboard sides to facilitate the rapid removal of cargo. The cofferdam at the forward end of the fore hold is unusual in such vessels, and is intended to preserve the cargo from damage should the ship spring a leak as a result of coming in contact with any one of the many locks through which she passes in her regular trading. There are two independent controls from the bridge to the engine-room telegraph, and the steam steering-engine is operated by rods from the bridge.

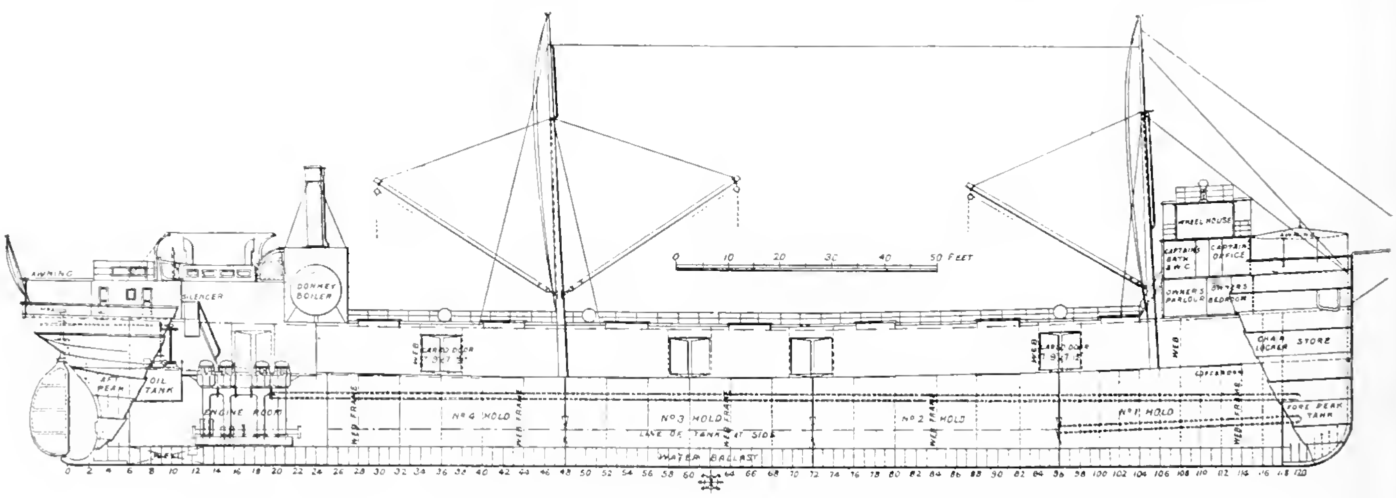
As with sister-ships, there are two masts with derricks on each, and the chart-house and navigating bridge are situated right forward. The rudder is balanced and is of large area. In the trials the vessel turned almost in her own length, and when the helm was put hard over she almost came to a dead stop.

The propeller is 11 ft. 9 in. in diameter by 9 ft. pitch.

The main propelling engine is a four-cylinder two-stroke cycle single-acting Carels type of Diesel oil-engine. The cylinder dimensions are 460 mm. (18.1 in.) diameter by 820 mm. (32.25 in.) stroke, and the engine runs normally at about 100 revolutions per minute. The bed-plate is of cast iron and is of the usual marine design, having a flat bottom and being supported in the centre as well as at the sides. This design contrasts with that evolved by many Continental makers, who prefer the bed-plate supported at the sides only, with the cross-members of deep box section carrying the main bearings, which have forced lubrication. The columns of the engine are of the usual box section, bolted rigidly together at the top, and are very thick, to withstand the tension stresses consequent upon the high pressures of the Diesel cycle. These tend to give great rigidity; the engine ran entirely free from vibration. With this design of support the bed-plate must be strong to take the bending stresses between the column feet and the main bearings.

The arrangement of the engine into two units of two cylinders each permits of a two-piece crank-shaft in interchangeable halves, of the vertical spiral drive for the valve gear being taken from the centre of the engine, and also of the scavenging-pumps being driven from the two centre crossheads by links, as with the air-pump of steam-engines. The dimensions of the double-acting scavenging air-pumps are 27¾ in. in diameter with a 23½-in. stroke, and give thus a ratio of free air compressed for scavenging to combustion air taken into the main cylinders of 1.65, which is higher than the usual practice. The pressure of the scavenging air is 3 lb. per sq. in.

The system of lubrication is interesting. For the main bearings solidified oil is used, for the crank-pin bearings the ordinary drip-feed suffices, and the bearing pressures for the main and crank-pin bearings are respectively about 300 lb. and 650 lb. per sq. in. For the lubrication of the crosshead bearing, a small lubricating-oil forcing-pump is attached to each crosshead, and worked by the swing of each connecting-rod, as shown. This system of lubrication permits of an open crank-case, and the bottom end bearings can always be easily felt by the engineer on watch. There are two guides tor each, such being Messrs. Carels' practice for oil-engines.



The Canadian Inter-Lake Ship "Fordonian."

Built by the Clyde Shipbuilding and Engineering Company, Limited, Port Glasgow.

The piston is lubricated by four Mollerup lubricators, which force the oil between the piston and the cylinder; there are four inlets to the cylinder, and they are arranged to enter on the fore-and-aft and athwartship centre lines.

The control of the engine is by means of one wheel and two levers on the starting-platform; one lever controls the compressed-air engine, which gives the cam-shaft its angular displacement by raising or lowering the vertical driving-shaft, and also gives the manœuvring-shaft its fore-and-aft movement. The other lever controls the fuel. The wheel operated by hand, gives the manœuvring-shaft its rotary motion. The cams upon the manœuvring-shaft act upon the suction-valves of the fuel-oil pump. Hand control is also provided by the handle on the column, which actuates a shaft running fore and aft on the engine, and so sets all the fuel-pump suction-valves. Although compressed air is used for actuating the vertical shaft, causing the angular rotation of the cam-shaft and the rotation and displacement of the manœuvring-shaft, hand-gear in emergency may be used.

Air storage for starting purposes is provided by four welded steel bottles, of 23⅝ in. diameter by 8 ft. long, and that for fuel injection by one bottle, 1 ft. in diameter by 3 ft. long. The pressure of the fuel injection air and the starting air is 850 lb. per sq. in., and for slow-running engines, such as this, this pressure is quite usual practice. The time taken by the auxiliary compressor to fill up the air storage provided is about one hour. The remainder of the auxiliaries are normal steam practice, and call for no special mention.

The weight of the main engine alone is about 100 tons, and if the auxiliaries are included, all ready for work, 150 tons is the weight of machinery abroad.

There is fuel storage in two oil-tanks placed on both sides of the oil-fired donkey boiler, and two ready-use tanks are placed aft of the engine-room, and are provided with steam heating coils, whilst the oil is filtered, on its way to the fuel-pumps of the main engines, through 15-gallon filters in the engine-room. In all 105 tons of oil fuel is carried, whereas with the sister steamships 250 tons of coal is required. The consumption per day for all purposes is 5 tons of oil fuel, against 14 tons of coal.

The fuel consumption of this engine is 0.47 lb. per brake horse-power per hour, and this is good practice for two-stroke cycle engines with the scavenging-pump and air-compressor driven off the main engine. The pressure of compression is 490 lb. per sq. in. The indicated horse-power at 102 revolutions per minute and 90 lb. per sq. in. is 970; 10 knots were achieved with the engines doing 128 revolutions per minute. The maximum revolutions were 140, the normal about 102, and the minimum 46. The results will undoubtedly be improved upon when the engines are finally tuned up, as prior to the trial trip they had only been run in dock trials for twelve hours in all. This is exactly the same treatment as is given to steam-engines.

The crank-shaft is in two interchangeable pieces, and there are two scavenging-pumps of large capacity. The auxiliary air-compressor is of half the capacity of the main compressor, and since the vertical shaft drive for the valve-gear is in the centre of the engine, should the compressor give out, one scavenging-pump fail, or even the crank-shaft break, the main engine will still develop more than half its normal power. This type of engine seems very suited to the propulsion of cargo boats, and the saving in space consequent upon the adoption of the Diesel engine for this ship is five frame spaces, aggregating 10 ft., some 33 per cent. of the machinery space.

A NATIONAL BOARD OF ENGINEERING CONTROL.

By Evolu.

[Some months ago Mr. T. Chase Casgrain, chairman of the International Joint Commission, offered two prizes for the best essays on the Formation of a National Engineering Service. The competition was held under the auspices of the Royal Military College Club and the Canadian Society of Civil Engineers. Through the kindness of Mr. Casgrain, we are enabled to publish the essays which obtained first and second prizes. The following essay, by Evolu, obtained first prize, and that by Observer the second prize.—Editor.]

Emerging from the Central Station in the city of Ottawa to proceed in the direction of Parliament Buildings it is necessary to cross a wide highway bridge spanning the Rideau Canal. The canal and the site of the bridge are enduring monuments to a corps of men whose work may be encountered in every quarter of the globe. Men whose motto is "Ubique": as Kipling says, "The men who do something all 'round' . . . the Corps of Royal Engineers."

The canal, built almost a century ago for purposes of defence, is still in the year 1912 a commercial asset to Canada.

To build the new highway bridge at Ottawa, known as the Plaza, it was found necessary to pull down the arch of the existing Sapper's Bridge, built under the direction of Colonel By in 1828. Before the old bridge could be torn down much labor and dynamite had to be employed. After the arch had been materially weakened a boulder weighing almost a ton, hoisted and dropped from a height of fifty feet, failed to complete the process of demolition. Only after repeated assaults and hours of battering did fall the works of these pioneer engineers; works built to endure, without thought of profit, works built for the common weal.

Thus it is wherever the works of the earliest engineers are found. The Great Wall of China, the Roman roads of Europe . . . how many engineers remember those schoolboy (sometimes painful) efforts to render a faithful translation of the chapter on bridge building in Cæsar's Gallic wars?

Some of the most enduring of the world's historic records are the works of the engineer, almost invariably of the military engineer. It would almost appear that engineering originated as a branch of the art of war, cultivated and developed as a department of state.

The passing of the feudal system witnessed the limitation of military government. But while war has declined, engineering has advanced into vast new fields: evolved from the art of war to the science of industrial civilization. And though some of the most remarkable modern achievements of the engineer, the appalling "Dreadnought" fighting machines and to some extent the Panama Canal, owe their existence to the new military method of preserving peace, nevertheless the civil engineer has outgrown his military parent. So that in modern states, such as the Dominion of Canada, even the military colleges are concerned in educating civil engineers.

Although an offspring may outgrow a parent it does not follow that the larger body necessarily must be the more efficient. There is much to be learned from the past. It would be well if every civil engineer could make a pilgrimage to Ottawa and read, mark, learn and inwardly digest the moral to be learned from those century-old works of the Royal Engineers and Colonel By.

Under the industrial system the stress of competition must be held responsible for tremendous waste and lack of

combined effort. Work and study have suffered through undue baste. Efficiency has been subordinated to expediency. But the error has been recognized. There would appear to be a growing movement in favor of engineering service organized by the state. Such a service may be found in France known as the Societé de Ponts et Chaussees; in India and Egypt where vast engineering projects are carried out by the Civil Service. In the United States the Army Engineers are responsible for the design and construction of federal works—harbors, waterways and canals; the engineering staff at the Panama Canal has proven such an efficient body it is suggested that the entire organization be retained and employed upon a great national undertaking in the Mississippi Valley.

In Canada the various public service departments have each a staff of engineers, but each departments works entirely independent of the others. Practically no steps are taken towards co-operation or systematic organization of the state engineers. In such a magnificent domain, awaiting development, with great engineering problems to be faced and solved, the day has arrived when some move ought to be made in the direction of the scientific handling of national projects. There is great need for a Supreme Court of Engineering.

Amongst the eight million inhabitants of Canada there is ample material for the formation of such a body. The great works of construction already in existence is good evidence of the nation's ability to accomplish any undertaking. National development could be reduced to an exact science by the organized efforts of experienced, far-seeing men, acting in co-operation, acquiring and recording information systematically.

It would not be proposed to make a revolutionary sweep of the present intricate system of departmental engineering, rather to form a nucleus around which the twentieth century organization could be gradually built up. Studying the history of industrial civilization all roads seem to lead to the principle of combination, evolution from distinct units to corporate organizations. The world's captains of industry appear to have worked out an unassailable method of assuring economic efficiency. Without aiming to effect a corner in technical experts—nationalization of the engineering profession is not yet above the horizon of possibility—it would be possible to draw together and form into, let it be termed, a Board of Engineering Control, a number of engineers with experience and ability sufficient to pronounce with authority upon any engineering project. It would be essential that such a board would be entirely non-political, as the Supreme Court of Justice is intended to be. In the engineering profession there is an abundance of public-spirited men doing faithful service in Canada and actuated entirely by love of their work.

In personnel the suggested National Board of Control could consist of five directors, equivalent to president and vice-presidents of a corporation. In the first formation directors might be appointed by a Royal Commission after due investigation of all conditions relating to the engineering expansion of Canada. The Board should have power to fill all vacancies in future, either by promotion or appointment; also power to select from amongst themselves a permanent chairman of the Board. The appointment of director should be for an unlimited period with retiring pension after a specified period of service.

As with the present system of Auditor General, the Board of Engineering Control should be responsible to parliament alone. The Board should have power to dismiss or appoint any subordinate and have authority to suspend or approve any public engineering contract.

Recall of any director could be enacted only by parliament. Each director upon entering office to be required to tender a formal resignation to the Governor-General in Council: the resignation being signed but undated. Should a reason arise making it necessary to recall any particular director a vote could be taken in the House of Commons. With the approval of the members the resignation of the director could be accepted. The date when resignation should take effect could be specified by parliament and filled in by the Governor-General in Council, thus effecting drastic control of any director by the nation through the national house of representatives.

Following upon the successful establishment of a board of directors the process of gradually building up a staff of expert engineers would commence. It would not be proposed to interfere with the regular working system of government departments, other than to consider and to report upon national projects, until the success of the Board, as an instrument for promoting economic efficiency, had been thoroughly established. But the ultimate aim would be transference of the purely technical work from the various independent units and staffs to the central authority of the National Board of Engineering Control.

Momentous questions are looming up regarding the policy of canal construction in Canada. To deal adequately with the great problem of freight transportation by water it would need a completely organized staff of canal experts. The logical proceeding would be to appoint a Chief Engineer of Canals and Water Service responsible to the Board of Control, with the necessary assistant engineers, draughtsmen and technical clerks. Departmental engineers with the necessary experience could be transferred to form the staff. In the process of time similar staffs could be built up, all directly under the Board of Control, to deal with railways, marine service, harbors, and the rest, until the majority of engineers at present scattered through the various departments would have assembled entirely under the direction of the Board. Where necessary a consulting engineer could remain on the staff of an administrative department. So that should questions arise regarding, for instance, the lease of a water power, it would be the consulting engineer's duty to see that the questions were submitted in their proper form with regard to the technical matter. Just as at present the law clerk or auditor of a department might be required to attend to questions coming under the jurisdiction of the Department of Justice or Auditor General.

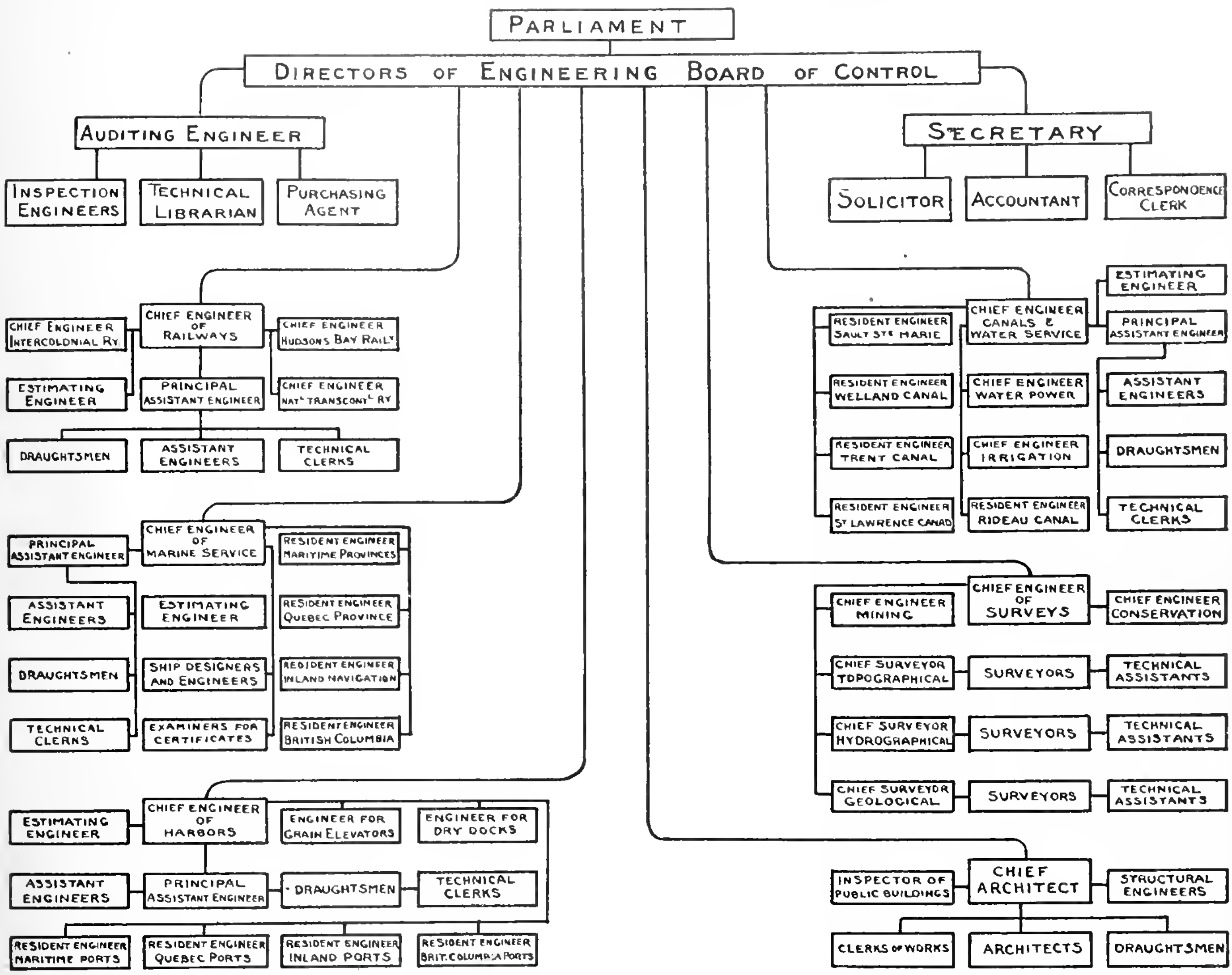
The staff of engineers responsible to the Board of Control would be men widely experienced in particular branches; the Chief Engineer of Railways an expert in railway engineering; Chief Engineer of Marine Service, a qualified engineer in marine work; the Chief Engineer of Canals and Water Service should include on his staff expert hydro-electric engineers and irrigation engineers; Chief of Surveys be responsible for all state surveying and conservation; and Chief Engineer of Harbors include a designer of grain elevators. Each chief engineer would have an estimating assistant who should be especially trained to deal with the economic branch of engineering: economics and finance being the most important features in civil engineering under the present day industrial system. It would be the estimating assistant engineer's duty to have reports prepared and estimates made dealing with the economic aspect of any proposed undertaking. Other assistants, electrical, mechanical, hydraulic, would be included on the staff where necessary. Bridge engineers under the Chief of Railways, ship designers under the Chief of Marine, draughtsmen, inspectors and technical clerks as the work demanded.

An auditing engineer would be responsible to the Board for fair and just expenditure upon such as inspection, sur-

veying, equipment, tools. The inspection and analytical staff, the technical librarian and the purchasing agent for Board of Control supplies also coming under the auditing engineer.

The secretary to the board to deal with correspondence and the direction of affairs through the proper channels, to be responsible through the solicitor for the legal drafting of contracts and specifications, through the accountant for the payment of salaries and accounts, also for advertising of public contracts, and other clerical work.

Thus, to use the diagramatic form of illustration, the proposed Board of Engineering Control might be organized on lines similar to the appendant plan:



The work of the board could be divided under a number of heads, namely, appraising, approving, estimating, surveying, designing, construction, maintenance. Perhaps the most important would be the work of collecting and tabulating information. There has been published at one time and another a tremendous amount of valuable information for the guidance of engineers and those who are concerned in the development of the country. But owing to the lack of cohesion amongst the various departments, and owing to overlapping, lack of responsibility, lack of system, much of the information has been neglected and practically lost. It would be the duty of the Board to place on record all information available regarding the cost of production and distribution of commodities. A technical librarian would be necessary to classify the information, such as reports, blue books, treatises, scientific publications, catalogues, price lists and other literature, and to arrange it in a system easy of access. The librarian could also be responsible for the filing of all maps, charts, plans and drawings, and for the making of blue prints and photographs.

Designing would necessarily occupy an important place in the work of an effective Board of Control. It has been the practice of state departments upon calling for tenders for some particular contract to allow each tendering firm to prepare and submit their own design with the tender. Such a process would not appear to be the most economic nor the most efficient. The system of varying the design according to the schemes of the various tendering firms is the cause of much wasted effort. It being possible to accept only one tender it generally follows that the unsuccessful designs produce nothing. But each design, whether used or wasted, has to be paid for, if not directly then indirectly by the community. Designs have to be prepared by experts. Therefore included in the bid of each tendering firm is a certain percentage to pay for the services of the expert designers. The percentage is usually sufficient to pay out of the profits of one successful contract, the expense (and a little more) of all tenders, whether the design be used or wasted.

For instance, supposing tenders are invited for the construction of an elevator at some point on the grain route, or for a ship, or a bridge, or a post-office—any public utility. Say five companies are invited to tender and submit their own designs. The average price bid may be one million dollars. Possibly five per cent. ($50,000) of the price may be included to cover cost of preparing design. The actual cost

of designing may have amounted to only $5,000: the extra $45,000 goes to pay for unaccepted designs in other unsuccessful tenders.

To the national exchequer a great saving in contracts could be effected by the Board of Control preparing its own designs.

Each contractor bidding upon a different design entirely nullifies the system of awarding contracts to the lowest bidder. The design of the lowest bidder may be, and usually is, far inferior to those of the higher bidders. Thus efficiency may be sacrificed to false economy.

By having one approved design only, each firm would be bidding upon an equal basis. The Board of Control could have sufficient copies of the approved design forwarded to the particular firms invited to tender, and the resultant bids could be compared in regular order ranging from highest to lowest.

Should the Board of Control require several different designs for consideration before inviting tenders, it would be quite possible to have different designs prepared by the staff. Or even to have competitive designs submitted from private, or corporation, consulting engineers, paying for accepted designs before calling for tenders on construction.

It would be the duty of the designing staff to prepare detailed specifications, and with competent inspectors to supervise the work, there would be some assurance that specifications would be followed faithfully, without misleading clauses.

Increased efficiency over the present departmental system of separate engineering staffs could be effected by combining under one management certain work common to several branches. The important and costly work of dredging could be conducted under the supervision of the Chief Engineer of Canals and Water Service instead of three several departments each carrying on dredging contracts. An experienced bridge engineer could be responsible for the accuracy of all important structural steel work. The naval architect under the Chief Engineer of Marine Service could design vessels, canal tugs, dredges, survey ships, lighthouse supply ships, irrespective of the branch under which they might happen to be controlled.

Contracting, or actual construction work, by state employees, is not looked upon with favor at present. There is an erroneous impression in Canada that it is more profitable to let out work to private contractors. But the day may come when the nation shall realize the moral of Sapper's Bridge and the Rideau Canal built by those state servants known as the Royal Engineers. The Board of Engineering Control should be competent to undertake such work when occasion called.

It should be within the power of the Board to compile a list of all corporations and contractors entitled to perform work for the state. Only firms, or individuals, upon the approved list to be afforded the privilege of tendering for state work. The Board to reserve the right to add to, or expunge from, the list any undesirable or defaulting contractor. Such a list is effectively used to maintain a high standard of efficiency in British Admiralty work, where the annual expenditure amounts to £45,000,000 (over two hundred million dollars per annum).

Outside engineering staffs, those of the national railways, canals, lighthouse engineering and the rest, would pass automatically under the control of the Board.

There would be practically no change in the routine work of the various departments outside of the technical staff. But by relieving the deputy ministers of the responsibility of attending to technical work there would be a great relief of pressure upon the several executive heads. A desirable state of affairs which one may be sure would be welcomed by the ministers of the Crown.

Qualification for an appointment under the Board of Control would be based strictly upon experience and ability as an engineer. Any attempt to introduce irrelevant influence, appeals to members of parliament or commissioners, or any other than the mode of application specified by the Board should be deemed sufficient to cancel an application.

With the successful establishment of the Board of Engineering Control responsible to the Federal Parliament it might be possible to expand the principle to the various provinces and towns, provincial and city, or local engineering boards being founded upon similar lines. Provincial Boards to stand in relation to the national board on a basis similar to the standing of the Provincial Courts of Justice and the Supreme Court, making it possible for a city or a provincial board to appeal to the national board where its opinion might be desired.

To sum up: Instead of the present system of disorganized units scattered in various departments the National Board of Engineering Control would draw together to act in co-operation a staff of men with the highest grade of experience in the engineering development of Canada. The board would act as a court of appeal to the many engineering projects vital to the country's well-being. All designs and expenditure for state work, down to the very smallest contract, would be examined and approved before authorizing the execution of the contract. Estimated costs would be prepared, economy, efficiency and accuracy would be ensured by the board before launching any state work.

With such an organization as the suggested Board of Engineering Control, Canada might hope to see greatly increased efficiency in the maintenance and development of national undertakings. And in the consideration of new projects more exact information and foresight. The engineering profession while growing more universal would grow also in stability.

And although the era of war, with its inspiration to great achievements in art and science, may pass, engineering in Canada and in the world would progress from triumph to triumph in the never-ending war between humanity and nature.

THE ORGANIZATION OF A CORPS OF CIVIL ENGINEERS FOR PUBLIC WORKS SERVICES IN THE DOMINION OF CANADA

By Observer.

In considering the suggestion for the organization of personnel for public works services in the Dominion of Canada, a brief description is necessary of departments for the carrying out of public services of an engineering nature in some other parts of the world; only two countries have been selected.

IN THE BRITISH EMPIRE.

(1) India.
(2) Colonial Possessions.
(3) The United Kingdom.

where the long record of successful engineering works carried out by engineers of our own race is one worthy of careful consideration.

IN THE UNITED STATES.

Where, to a certain extent, natural features and climatic conditions have presented engineering problems similar to those of the Dominion which have been handled by engineers with educational qualifications of a similar nature to those acquired at Canadian engineering institutions.

An outlined scheme for the development of a public works service in Canada will then be put forward for consideration.

The British Empire.—In newly acquired territories it has been the usual procedure that, during the process of development, the government has turned to military engineers to carry out the pioneer work of the country. As the public works increase in importance and magnitude and the country settles down, the formation of a civil engineering department has been undertaken, recruited partly from the military engineer corps and partly from civil engineering institutions.

The difficulty in the organization of these departments has been in the adjustment of the conditions of service for the personnel recruited from the two sources, so that they shall work together harmoniously, the strong points of the one class supporting the weak points of the other.

The military engineer brings to the public service a good general education, the power of organization, and a ground work of engineering knowledge on many subjects coupled with the habits of obedience and discipline acquired from his military training.

The civil engineer brings a higher standard of engineering knowledge from a specialized course at an engineering college; he is, as a rule, a specialist in one particular line, in which he excels over his military confrére; but he is not so adaptable as his rival, who usually has a better grounding in general education on which to build technical knowledge during his career. Moreover, the attractions of an independent engineering career in civil life, with its higher rewards for success, draw away the best class of engineers from the public service, which appeals more to the engineering graduate of lower attainments and less ambition, who is drawn by the fixed salary on a graduate scale, and the prospect of a pension in later years.

The selection of candidates for the public service in Great Britain, India and the Colonies, is made under certain conditions by competitive examination tests conducted by a public examining body termed civil service commissioners, who are appointed "at pleasure" by orders-in-council.

The civil service commissioners in the Uniter Kingdom, who examine candidates for entry into the public service in all its many departments under conditions laid down by these departments, consist of two commissioners only, who hold office practically for life, so as to ensure continuity of policy and procedure.

These commissioners select examiners and critics for the preparation and marking of examination papers, exercise a general control over the papers set, and conduct the detailed arrangements for examination, namely, publishing announcements of examinations and syllabi, collecting entries of candidates, supervising written and practical examinations of candidates, checking, collating and recording marks, and preparing and publishing lists of results.

INDIA.

The Railway Department deals directly only with railway systems that are the property of government; the department is sub-divided into two main branches: (1) Construction, and (2) Traffic. **Construction** includes the survey and construction of new lines and the maintenance of existing lines. From this branch are selected the consulting railway engineers to government, whose duties cover the inspection of lines owned or worked by companies.

The Traffic branch handles passenger and freight traffic on open lines; from this branch the managers of both state-owned and company lines are usually selected.

Locomotive and audit branches, with personnel recruited from other sources, are usually separate from the other two.

The Public Works Department is divided into two branches:

(1) Buildings and Roads.
(2) Irrigation.

The Building and Roads Branch deals with the construction and maintenance of all government buildings and main roads, outside military cantonments. The country is divided into areas corresponding to the civil administrative districts, with public works department officials on the staff of the civil administration.

The Irrigation Branch controls the construction of new canals and reservoirs, the maintenance of existing irrigation works, and the distribution of water for agricultural and other purposes. Irrigation is carried out either by diverting the supply from the main rivers by means of canals (Punjab and Ganges Canal System) or by damming large catchment areas to retain the periodical rainfall either by one large tank or a series of smaller ones, (Mysore Tank System). The largest projects undertaken are the Periyar Reservoir, and the Mari Kunaway Reservoir, the latter having a water area of 120 square miles.

The engineers in the higher grades are drawn partly from the Royal Engineers and partly from civil engineer graduates in the United Kingdom.

The Royal Engineers remain on the active list of the corps, receive periodical military promotion, qualify for military pensions, and are liable to recall to military duty when required; they receive pay at civil rates, department promotion and periodical furloughs (on military pay) similar to the civil engineers of the railway and public works departments.

The commissioned ranks of the Royal Engineers are recruited by competitive examination amongst the cadets of the Royal Military Academy, Woolwich, after a two-year course of study; about thirty commissions are offered annually (one commission annually is offered at the Royal Military College, Kingston). After receiving a commission in the Royal Engineers, and before proceeding to India, a two-year course is followed at the School of Military Engineering, Chatham, including occasionally a six months course of instruction on a British railway.

Engineers of the public works department are lent to native states in India for local public works departments; Lieut.-Colonel Joly de Lothbiniere, R.E., a graduate from the Royal Military College, Kingston, has served in the states of Mysore and Kashmir, being at present chief engineer in the latter state.

The civil engineers used to be recruited from the Royal Indian Engineering College at Cooper's Hill, England, after a three years course of study. This college was abandoned some years ago, and now civil engineers are obtained by competitive examination from graduates at engineering colleges in the United Kingdom. The supply, however, hardly meets the demand, and there is a tendency to increase the proportion of Royal Engineer officers in the higher grades.

The various grades in the railway and public works departments with approximate rates of pay for each year's service are as shown below; these rates of pay are not so high as are given in the army administrative departments in India, (i.e., supply and transport, ordnance and accounts); it has also to be remembered that Royal Engineer officers have to keep up military uniforms, equipment and field kit, pay regimental subscriptions, meet extra expenditure involved by active military service, and receive less favorable pay while on furlough than the civilian engineers in the Indian public works department.

Approximate Rates of Pay in Public Works Department, India, by Length of Service.

Years of Service	Military Rank in R.E.	Grade in P.W.D.	Rate of pay per mensem	Equivalent in Dollars per Annum
32	Colonel	Chief Engineer, 3rd grade	2127 Rs.	$8,508

There are two higher grades of chief engineer.

Approximate Rates of Pay in Public Works Department, India, by Length of Service.

Years of Service	Military Rank in R.E.	Grade in P.W.D.	Rate of pay per mensem	Equivalent in Dollars per Annum
31 30	Lieut.-Col.	Superintending Engineer, 1st grade	1915 Rs.	$7,660
29 28	"	Superintending Engineer, 2nd grade	1861 Rs.	$7,244
27	"	Superintending Engineer,	1692 Rs.	$6,768
26	Major	3rd grade	1540 Rs.	$6,160
25 24 23	"	Executive Engineer, 1st grade	1445 Rs.	$5,780
22 21 20	"	Executive Engineer, 2nd grade	1149 Rs.	$4,596
19 18 17 16	Captain	Executive Engineer, 3rd Grade	939 Rs.	$3,756
15 14 13 12	"	Assistant Engineer, 1st grade	780 Rs.	$3,120
11 10 9 8	Lieutenant	Assistant Engineer, 2nd grade	548 Rs.	$2,192
7 6 5 4	"	Assistant Engineer, 3rd grade	496 Rs.	$1,984
3	2nd Lieutenant	"	439 Rs.	$1 756

The following Indian military pensions may be earned by Royal Engineer officers, who have served all their time in India (except three years at the School of Military Engineering and with the Royal Engineer units in England under 15 years' service):

After 20 years' service, 250 pounds per annum.
After 24 years' service, 365 pounds per annum.
After 26 years' service, 432 pounds per annum.
After 28 years' service, 500 pounds per annum.
After 30 years' service, 600 pounds per annum.
After 32 years' service, 700 pounds per annum.

Survey of India.—Besides the railway and public works departments there is another public department in India which is entirely manned by military officers, the survey of India.

This department is divided into three branches: Trigonometrical, Topographical and Revenue.

For those gifted with a talent for higher mathematics, a liking for delicate instruments, and an interest in geodesy and astronomy, the trigonometrical branch affords full scope. The framework of all mapping is based on the work of this branch.

The topographical branch carries out any original topographical work (nearly all the country within the British frontier has now been surveyed) and periodical revisions of existing maps; about six or eight months are spent under canvas every year.

The revenue branch prepares cadastral plans for revenue purposes in settled districts.

Besides these branches some officers are employed on tidal and magnetic surveys, and in the instrument and map producing offices at Calcutta.

The rates of pay are slightly higher than in the public works department; the officers belong to the Royal Engineers, with a few specially selected officers from the Indian army.

Indian Telegraph Department.—This department used to draw on Royal Engineer officers to fill the higher grades, but as a succession of Royal Engineer officers filled the post of director-general for some years, it was decided that the employment of military officers was not in the interests of the civilians in the department.

Except for a few junior Royal Engineer officers under instruction for two years, none have been employed in recent years. This department has recently been amalgamated with the post office department, following the post and telegraph organizations in the United Kingdom. No private telegraph or telephone companies are allowed in India; these services being reserved for government revenue purposes.

The personnel of this department used to be recruited principally from the Royal Indian Engineering College, Cooper's Hill, but in recent years candidates have been selected by open competitive examination held by the Civil Service Commission, followed by a course of instruction at a University in the United Kingdom.

Railway Construction by Military Labor.—It is very customary for sapper and miner companies, under their own officers, to be employed on railway construction work by contract, in unsettled districts, or in districts where civil labor is difficult to obtain.

The Khushalgarh-Kohat-Thol Railway on the northwest frontier, and parts of the Southern Punjab Railway, amongst many others, have been entirely constructed by military labor under military contract.

The sapper and miner companies draw their ordinary regimental pay from army funds; while, instead of engineer pay, a contract is agreed upon between the railway department officials and the commanding officers concerned.

The number of Royal Engineer officers at present employed in the government departments in India is as follows:

Railway Department.

Managers and assistant managers	5
Engineering department (including government consulting engineers)	37
Traffic department	5

Public Works Department.

Road and buildings	23
Irrigation	5
Miscellaneous civil appointments	13

Survey of India.

	40

EGYPT AND THE SOUDAN.

When Egypt was first taken over for administrative purposes after the downfall of Arabi Pasha, in 1882, the country was administered entirely by military officers.

Gradually, as the country settled down, the military administrators and engineers were replaced by civilians, and the military officers concentrated for constructing the military railway, which eventually carried the British flag back to Khartoum.

Since the overflow of the power of the Khalifa the government of the Soudan has been carried out under military administration.

The governors of provinces are infantry officers, seconded from their regiments, while the postal and telegraph department, survey department, public works department, are entirely controlled by engineer officers.

The Soudan Railway, from Port Soudan on the Red sea to Khartoum, with its branches, is also entirely controlled by engineer officers.

The following number of Royal Engineer officers are at present employed:—

Soudan Railway	6
Posts and telegraphs	2
Public works department	3
Survey	1

besides six officers on the railway, telegraph and survey departments in Egypt proper.

COLONIAL POSSESSIONS IN AFRICA.

Besides the military governors and administrators in the various Crown colonies and dependencies in Africa (excluding United South Africa) the surveys of the British African possessions are being carried out by some twelve Royal Engineer officers, besides four employed on railway and road work.

The Baro-Kano Railway in Nigeria and the Uganda Railway have furnished employment for many engineer officers.

THE UNITED KINGDOM.

Telegraphs.—The general post office in Ireland furnishes permanent employment for officers, non commissioned officers and men of "K" Telegraph Company of the Royal Engineers, seven officers and about 150 other ranks. The officers are selected from those who have served in the field telegraph units, while the men are specially recruited from telegraph employees of the general post office. The men undergo a short course of military training and then return to their civil duties under the general post office (on civil rates of pay), but retain liability to recall to the colors when required for active service and periodical training. Practically all the telegraphs in the South of Ireland are worked by "K" Company Royal Engineers.

Special Reserve of Officers for General Service in the Royal Engineers.—In addition to the regular officers of the Royal Engineers, a reserve of junior officers for employment on active service was started in 1900.

Before appointment a candidate must have qualified by examination as an Associate Member of the Institute of Civil Engineers.

After appointment the special reserve officer carries out a short course of military training at the School of Military Engineering, Chatham, and is expected to do a short annual training with a regular engineer unit on field training and manœuvres.

No promotions are made above the rank of captain, nor will any officer be retained in the reserve above the age of 45 years.

There are at present 91 officers on the reserve list, but of these the following are shown as "on leave":

In India	18
In Africa	11
In Canada	4
Elsewhere abroad	6
	39

It will be seen, therefore, that no restriction is placed on young engineers leaving the United Kingdom, but they remain liable to recall to military duty when required.

An annual retaining fee is paid, with military pay and allowances while under instruction or training.

The Ordnance Survey in the United Kingdom is manned principally by engineer officers and men in the Survey Companies of the Royal Engineers. The control is entirely in the hands of engineer officers.

The department originally started under the master general of the ordnance (hence its designation), as the necessity of systematic mapping work was, and always has been, first recognized by the army. After subsequent reorganizations, it has now been placed under the home office, by which part of the pay and allowances of the personnel are provided.

The existing topographical maps on various scales are revised periodically, and cadastral plans prepared as required; the production of maps and distribution on payment to the public are also entrusted to this department, in which twenty Royal Engineer officers are employed.

Other Government Departments provide employment for engineer officers on the retired list as follows:—

Board of Inland Revenue	1
Board of Education	1
Board of Trade, London traffic	2
Government railway inspectors	4
Local Government Board	2
Admiralty (Works Department)	1
Light Railways Commission	1
Prisons Commission	2
Crown agents for colonies	2
Office of Works	3
General post office	2
Total	21

From the above brief description of the duties and emplopment of the commissioned ranks of the Corps of Royal Engineers, it will be seen that their duties are many and varied, and that the government has not hesitated to employ military engineers to a great extent on duties unconnected with the military profession. It is no doubt a system which is full of anomalies and capable of improvement, but it is the the result of many years' slow development, and it is worth taking into consideration when formulating proposals to suit Canadian conditions.

THE UNITED STATES.

The corps of engineers in the United States army was first organized on a small scale under a Federal Act in 1802. Between 1808 and 1863 a separate Bureau of Topography and a corps of topographical engineers was established under the War Department, being finally merged in the latter year into the corps of engineers.

The corps of engineers was first employed on public works service in 1824, when the President was authorized "to procure the necessary surveys, plans and estimates upon the subject of roads and canals." This work was to be carried out "by two or more civil engineers and such officers of the corps of engineers, or who may be detailed to do duty with that corps, as the President might think proper."

From the year 1832 both the corps of engineers and topographical engineers have been constantly employed in public works under the federal government; in fact, until recent years these have been the only government officials who have been available to carry out technical duties of this nature.

Amongst the works carried out may be cited:—

Construction of roads and canals.

Survey of the coast of the United States.

Light-house service.

Bridges.

Harbors.

Reclamation of land.

Railway surveys, including that from the Mississippi to the Pacific Coast in 1853

All public works in the District of Columbia.

And last, but not least, the construction of the Panama Canal.

The successful execution of this latter work being largely due to the co-operation of the military medical department in sanitary work.

As has been the experience in the British Empire during the process of developing the country the civil engineering work has largely been carried out by military engineers. As the country has developed the work has been taken out of the hands of the military engineers, and has been entrusted to civil engineers employed permanently or temporarily by the federal government.

Public works under the control of the various States have, however, been carried out by civil engineers, as no military engineers have been available for States duties.

The same procedure has been adopted in Cuba and the Phillipines on their acquisition by the United States; all administrative legal and technical work of government has has been carried out by soldiers, as has been the case in British possessions.

It has not been custom ary to a ward any higher rates of pay to engineer officers employed on public works than are allotted to officers employed on ordinary military duty. These rates, however, are considerably higher than are paid to officers of the Canadian permanent force or Royal Engineer officers employed on regimental duty.

CANADA.

In Canada the main sources of supply for engineers are:

(a) The Canadian universities, which are in close touch with the principal employers of labor in the country, and which have adopted courses of study particularly suited to local conditions.

(b) The Royal Military College of Canada, where a course of study embracing both civil and military subjects, has been adopted, and whence a large proportion of graduates adopt a civil career, either directly after they leave the college or after a subsequent course at a Canadian university.

(c) The lower grades of the engineering profession in which practical experience is gained by work commencing often at an early age, in the elementary and unskilled stages; finally, after a long apprenticeship, personal ability, skill, and engineering knowledge acquired by years of practical work, have enabled many of the foremost Canadian engineers of the present day to rise to the top of their profession.

The system of selection to fill engineering appointments in private as well as in government service has, however, been somewhat haphazard. Personal influence, as well as political considerations, have often been the determining factors in selecting candidates for appointments. In the absence of any obligatory theoretical engineering qualifications particular attention has usually been paid to practical, as opposed to theoretical, qualifications.

Four years of practical experience in the unskilled branches of the profession are often held of more account than a four-year course of study at a university.

The three government departments in which officials with technical engineering knowledge are required, are:—

Department of Railways and Canals.
Department of Public Works.
Department of the Interior (for topographical surveyors).

Outlined Scheme for Canadian Public Works Service.— It is suggested that a public works service be formed in Canada, consisting of two main divisions.

The first division to consist of higher officials with the grades of:—

Assistant engineer.
Executive engineer.
Superintending engineer.
Chief engineer.

The second division to consist of subordinate officials with the grades of:—

Foremen of works, and other lower grades, with at least six different classes.

Appointments to the second division to be made by selection from those who have served an apprenticeship in practical work. Opportunities would be given to selected men of this division to transfer to the first division, by reserving a proportion of the appointments therein annually for nominations amongst especially qualified foremen of works.

Direct appointments to the first division to be made by open competition, held by a permanent examining board appointed by orders-in-council, among graduates in certain specified branches of engineering at Canadian universities.

Graduates from the Royal Military College, Kingston, would be eligible to compete, but only after they had completed their three-year course at Kingston by a fourth year at a Canadian university. The course of instruction in engineering subjects at the Royal Military College, Kingston, would require revision so as to bring it into line with those arranged for the first three years course of study for an engineering degree at Canadian universities. As many subjects, other than civil engineering, are studied at the Royal Military College, Kingston, the standard required from Royal Military College graduates at the end of their fourth year at a university would necessarily be lower than that required from other graduates.

On appointment to the first division of the public works service candidates would be graded as assistant engineers and encouraged to specialize in one particular branch of engineering.

A further course of instruction at a university in special branches of engineering might be arranged during the winter months for assistant engineers with at least four years practical experience in departmental work.

The rates of pay in the grade would be based on (a) length of service; (b) actual appointment held.

An annual rate of pay on a graduated scale according to length of service, with additional "grade" pay as assistant, executive, etc., engineer, would be the most satisfactory solution. Graduated pensions, after 20 years government service, would induce good men to remain in government service late in life.

Appointments to the various grades would be made by selection according to the importance of the duties to be carried out and to the capability of the engineer. There should be no restriction to a junior engineer holding an important appointment (with "grade" pay accordingly) if he were professionally capable to hold the position. The less gifted members would receive annual increments of pay in the lower grades for the length of service.

In order to bring the engineers of the public works service into closer touch with those employed by private firms, the former should be permitted to accept appointments in private firms, if offered to them; but after the conclusion of a fixed term of years (seven or ten) with a private firm, they should be required to retire from the public works service or to return to government duty. While employed by a private firm a contribution towards pension would be required, so long as the public works department engineer remained eligible for a government pension.

In each government department the senior public works official would be the head of the service in his particular department. All appointments, promotions, and transfers of public works officials would be made by the responsible minister on the recommendation of the head of the public works service in his department, who would always be a permanent government employee, unaffected by a change of government.

A society of the public works service, composed of public works officials in all departments, with an elected president and council, would ensure stability to the service, and would be a connecting link for the furtherance of the interests of the members in general.

The creation of a scientific public works service in Canada, organized on the above lines, would provide a strong body of men, possessed of experience in technical matters, sufficiently permanent in government employ to ensure continuity of policy, and capable of placing at the disposal of Canada's representatives in parliament technical advice on economics, as well as engineering, questions, which would go far towards the expenditure of public funds to the best advantage of the Dominion

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD,
MARINE AND MINING ENGINEER, THE SURVEYOR,
THE MANUFACTURER, AND THE
CONTRACTOR

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc. MANAGING EDITOR — A. E. JENNINGS, ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc. CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914 G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address n full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, JANUARY 23, 1912. No. 4.

CONTENTS OF THIS ISSUE.

A NATIONAL ENGINEERING SERVICE.

Any engineer who has stopped to consider the question of civil engineering as handled with regard to Government service in Canada, must be struck with the general lack of efficiency and the overlapping of departments in the Canadian Government service.

Mr. T. Chase Casgrain, chairman of the International Joint Commission, a few months ago offered two prizes for the best essays on the "Formation of a National Engineering Service." In this issue will be found the two essays which secured first and second prize. These articles will repay careful reading, for they show very clearly some of the difficulties of the present conditions at Ottawa.

As conditions now exist, a number of departments of the Government service carry on work in which the engineering profession are vitally interested, and for which members of that profession are responsible, both in design and execution. A lack of efficiency is conspicuous throughout a great deal of this work. Several departments are carrying on work of the same character which, logically, should be under one head. As a result, there is a duplication of staff and equipment. Petty jealousies arise between the different departments, and there is little incentive to consistent and loyal work on the part of the individual members.

Evolu, in his article on "A National Board of Engineering Control," suggests the appointment of a board of control directly responsible to Parliament. All work of the same nature would logically come under one department and under one man. Increased efficiency would, no doubt, result, and the present lack of cohesion among the various departments, due to the overlapping, lack of responsibility and lack of system, would be obviated. The combining under one management of the work common to several branches would result in the work being done far more cheaply and economically than under the present system.

Probably one of the greatest improvements which would come as a result of the appointment of such a board of control would be the removal of all appointments from the sphere of politics. Appointments would be based strictly upon experience and ability.

There is no logical reason why the work of the government should not be carried on as economically and efficiently as that of a private organization. Until some such method is used, however, as is outlined in these articles, the present state of affairs will continue. It is to be hoped that this move on the part of Mr. Casgrain will be instrumental in drawing the attention of the public to the present state of affairs.

A PROSPECTIVE COURSE OF CERAMICS IN UNIVERSITY OF TORONTO.

The Canadian Clayworkers' Association, meeting in Toronto Tuesday, Wednesday and Thursday of last week, have revived with renewed vigor a movement to establish in the Faculty of Applied Science and Engineering, University of Toronto, a course in Ceramics.

This movement on the part of the executive is the result of a deeply-felt need experienced by the manufacturers of clay products for technical knowledge of the properties of the raw materials, and for more scientific methods in the process of manufacture.

No sooner had it been decided to take steps in this direction than a United States brick machine company

came forward with an offer to furnish any Canadian university disposed to inaugurate such a course with a fairly complete laboratory equipment consisting of a brick machine, grinding-pans, automatic cutter dies, and other necessities.

The president and the Board of Governors of the University of Toronto have expressed their sympathy with the desire of the Canadian Clayworkers' Association for the founding of a course in Ceramics. President Falconer, as the representative of the Board, stated that it was entirely a question of funds, and he impressed upon the deputation which waited upon him the necessity of bringing the matter before the Provincial Government in order that funds might be provided for such a course.

It is vitally important to the clayworkers' industries of the Province of Ontario, and, in fact, of the Dominion of Canada, that a department of Ceramics should be founded in the immediate future. The Provincial Government must not withhold the requisite aid for technical instruction in one of the most important industries of the Province.

TORONTO'S WATER SUPPLY.

Our criticisms of the report of the Board of Water Commissioners are not based on the question of the possibility of water not being able to run down hill or, as put by Mr. Randolph, on the question of the suspension of the law of gravitation, but on the question of hydraulic design, and economical construction, maintenance and operation.

Since our last issue appeared, one of the Commissioners, Mr. T. Aird Murray, has written to the Board of Control to state that his opinions regarding the feasibility and desirability of the Scarboro scheme had changed since he signed the report. He stated that he had serious doubts from the first, and he now withdraws from responsibility for the report. If Mr. Murray devoted so little time and attention when the report was being compiled that he did not fully appreciate what he was recommending, and if his attitude is typical of the other members of the Commission, certainly very little reliance can be attached to the report. His belated objections to their recommendations are based on facts of which, he says, he was cognizant during the compilation of the report; therefore, his conclusions as now presented to the Board of Control are diametrically opposite to those for which he received his fee.

It is only fair to *The Canadian Engineer* to state that the criticisms of the Scarboro water scheme which appeared some two weeks before Mr. Murray's letter to the Board of Control are not those on which Mr. Murray bases his objections to the report.

Our objections to the location may be summarized in very few words: The quality of the water is no better than that of Centre Island, and must be continuously filtered. There will be a greater first cost of construction; greater continuous cost of operation; greater cost of maintenance; and the lack of flexibility of the gravity scheme as compared with direct pumping.

For the benefit of the daily press in Toronto, which appear to feel that the question at issue is whether the water will flow down hill from Scarboro or not, we would like to call attention to an article which appeared in the January 9th issue of *The Canadian Engineer*, describing the Los Angeles Aqueduct. The length of this aqueduct, which supplies water for the city of Los Angeles, a municipality of 400,000 population, is 234 miles, and the fall is 1,500 feet. There are many other gravity systems in successful operation, but this particular Scarboro scheme is criticized in connection with the local conditions.

Our objections to the report are based on the fact that we do not believe that the Board of Water Commissioners have presented a practical plan.

Commissioner Harris has stated that the by-law to provide the requisite funds for the construction of a duplicate water supply was intentionally worded in such a way as to leave the choice of location and the details of design open. We have every confidence that Commissioner Harris, before he proceeds with the construction, will thoroughly investigate the whole situation and base his decision on the principles of engineering economics and design. To make his decision, he does not need the arguments of certain of the commissioners in favor of the Scarboro location (arguments which should have been presented with their report) or the repudiation of the recommendations in the report (a repudiation which should have been presented as a minority report) by the Commissioner who has changed his mind.

EDITORIAL COMMENT.

Do not forget the Annual Meeting of the Canadian Society of Civil Engineers in Montreal next week.

* * * *

The description of the plant of the Mississippi River Power Company in this issue will, we are sure, be of interest to all our readers.

OZONE TREATMENT OF WATER.

In some of the larger European cities the water supplies are sterilized by ozone treatment used as the sole means of purification or in conjunction with filters. The largest installations in which ozone is employed are the following:—

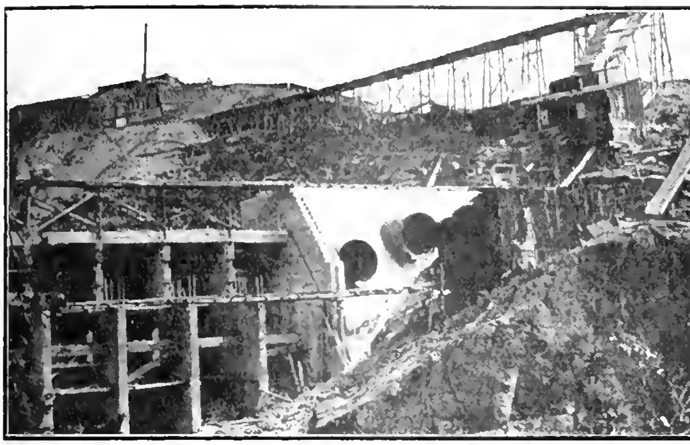
Locality.	Capacity, gallons per day.
St. Maur, Paris	13,000,000
St. Petersburg	11,000,000
Nice	10,000,000
Wiborgen	2,640,000
Florence	1,100,000
Wiesbaden	660,000
Hermannstadt	880,000
Chartres	325,000

There are also two new plants supplying the city of Paris which will have a total capacity of 12,000,000 gallons per day.

In America little progress has been made in the use of ozone owing primarily to its excessive cost. In the European plants the average cost of treatment is $10 per million gallons. The hypochlorite treatment in this country offers opportunity for efficient sterilization without an excessive outlay. Recently, however, a small plant at Great Falls, S.C., with a capacity of 80,000 gallons per day, has been installed, and it is claimed that the cost of treatment does not exceed $5.00 per million gallons. The principal objection to the ozone treatment has been its excessive cost and if this objection can be met it may be expected that the use of ozone will greatly increase.

HYDRO-ELECTRIC DEVELOPMENT ON THE MAGPIE RIVER.

About fifteen miles north of Michipicoten, in the province of Ontario, a dam has been constructed on the Magpie River, just above the falls known as Steep Hill Falls; the object being to develop electric energy for the use of the iron mines belonging to the Algoma Steel Corporation, of Sault Ste. Marie. The distance from the Helen mine is about five miles, and from the Magpie mine, twelve miles. A wood-pole transmission line, designed for an ultimate pressure of 22,000 volts carries the three-phase aluminum conductors from the power station to the mines. The pressure, in the first instance, will be 11,000 volts, and generators wound for this voltage will be connected directly to the line. If it is desired to step-up to the higher pressure at a later date, transformers with a ratio of one to two will be installed. The step-down transformers at the mines are suitable for either 11,000 or 22,000 volts on the primaries, with a secondary pressure of 600 volts.



Down-Stream View of Dam, Showing Position of Steel Penstock.

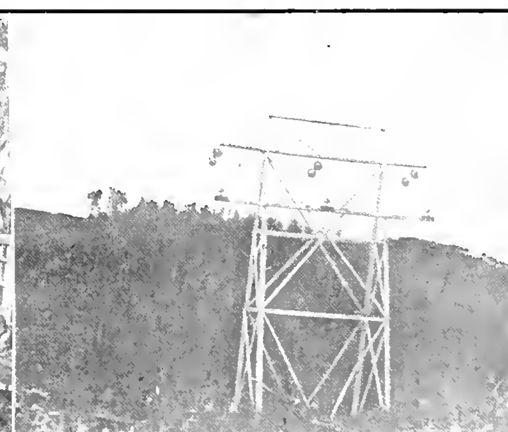
View Looking Down-Stream During Construction.

The dam, which is now completed, is of the Ambursen type, built of reinforced concrete with buttresses spaced twelve feet apart, supporting deck slabs tapering in thickness from 30 inches at the bottom near the cut-off wall, to 17 inches at the top. The height of the spillway above river bed is 45 feet and the total length of spillway is 145 feet; the overall length of the dam being 230 feet. There are 2,800 cubic yards of concrete in the dam, the mixture being 1 part cement, 2 parts sand, and 4 parts crushed rock in the cut-off walls, decks and spillway; while a 1:3:6 mixture is used in the buttresses and the solid work at both ends of the dam. About 65,000 lbs. of reinforcing steel, mostly in the form of ⅞ in. square bars, are imbedded in the concrete of the dam.

The dam is so constructed as to allow of the height being raised another 12 feet at a future date. With the spillway at its present elevation, the reservoir created on the upstream side of the dam is of negligible capacity, and is practically useless for storage purposes, the power available for a continuous supply of energy being determined by the quantity of water available at times of minimum flow.

Much of the concrete work on the dam was put in during the winter months in the early part of 1912, and as the winter temperatures in this district north of Lake Superior are very low, great care had to be exercised to prevent the too rapid cooling of newly placed concrete. During the months of January and February the thermometer very frequently stands at 40 degrees below zero, and temperatures between 50 and 60 degrees below zero were actually recorded. The water, sand and rock were steam heated, and after the concrete was placed, it was covered with canvas and every possible means employed to maintain it above freezing point until it had set. Under such conditions the forms have to be left in position considerably longer than when the concrete is placed under ordinary conditions. It is, however, a notable fact that the concrete put in during the cold weather was generally satisfactory.

Eight-foot Steel Penstock from Power House Site.



Steel Tower Supporting 1,000-ft. Span Over Ravine.

The total head available for driving the turbines is in the neighborhood of 60 feet. The power house, now nearing completion, is situated at the foot of the falls. It is being equipped with two turbines of the horizontal type, supplied

by Messrs. Hamilton and Company, Peterborough. These will develop 1,000 h.p. each and will be direct coupled to three-phase generators supplied by the Crocker-Wheeler Company, of Ampere, N.J., and designed to develop 900 k.v.a. at 11,000 volts, when running at 400 revolutions per minute. The continuous current for the generator fields is provided by a separately driven exciter, direct coupled to a water turbine supplied by the Rodney Hunt Company. The switchboard is supplied by Ferranti, Limited, of Manchester, England, and it provides for the hand operation of oil type switches on generators and feeders, through a simple system of levers.

The elevation of turbine shaft above low-water level in the pool at the foot of the falls, is 21 feet; but in seasons of flood, the water in the lower pool may rise as much as 8 feet. The water is brought to the turbines through a steel penstock 240 feet long, taken down the side of the river bank through a channel cut in the rock; the difference of elevation between top and bottom ends being 43 feet. Provision has been made for two penstocks, but one only is necessary for the operation of the 2,000 h.p. plant at present being installed.

The intake is closed by racks consisting of bars ¼ in. thick, spaced 1 9/16 in. apart, the total area of rack being 230 square feet.

The penstock, where it is built into the dam, is 8 feet in diameter, made up of ¼ in. steel plates which are increased to ⅜ in. at the bottom near power house. Just outside the power house, the pipe divides into two 6 ft. branches leading to the turbines. A surge tank is also provided at this point. It measures 12 ft. diameter, and has a total height of 80 feet, which brings the top of the tank 26 ft. above the level of the present spillway. The surge tank is built up of riveted steel plates 7/16 in. thick at the bottom, reduced to ¼ in thick at the top.

Two separate three-phase circuits leave the generating station. These are carried together on one set of poles for a distance of about 1¼ miles, where they branch off; one line going south to the Helen mine, and the other going north to the Magpie mine.

Three-phase current is used almost entirely at the Helen mine, not only for the main hoisting engine, but also for the various motors driving crusher, air compressor, conveyers, pumps, etc., both on the surface and below ground. At the Magpie mine, where the most up-to-date machinery is being installed, including a large travelling bridge for the handling of the ore, together with gas generators and complete calcining and roasting plant, a portion of the three-phase current, after being converted to 600 volts pressure, is used for driving a motor generator to provide continuous current for the motors on the ore bridge and other purposes.

The address of Dr. Allen J. McLaughlin, assistant surgeon of the United States Public Health Service, Washington, D.C., last month before the annual meeting of the Association of Life Insurance Presidents, on "The Effect of Safe Water Supplies on the Typhoid Fever Rate," was illustrated by a series of ten charts. Dr. McLaughlin presented an interesting comparative table showing the contrast between the typhoid mortality of fifteen of the largest American cities and fifteen of the largest cities of Europe. The lowest typhoid death rate abroad was 1.3 per 100,000 of population in Edinburgh, and the highest 5.6, in Paris. The lowest death rate from typhoid in American cities was 8.8 per 100,000 of population in Cincinnati, and the highest, 58.7, in Minneapolis. The Philadelphia mortality is 17.5 per 100,000, and that of Pittsburgh, 27.8.

STREET CLEANING IN PORT ARTHUR.

By W. S. Bowden, Street Commissioner.

The proper cleaning of paved streets has become a necessity. Vast sums of money are being spent every year by almost every town and city in Canada in the construction of high-class pavements designed to improve their principal streets, and business centres. And no municipality that has undertaken to improve and beautify their city this way, for the convenience and benefit of their citizens and the public generally, can possibly afford to overlook the great importance of this work. In fact it is frequently the case that a town or city gets its reputation from the condition of their streets; for beauty and cleanliness are qualities which catch the eye of every visitor, call forth admiration of every tourist, and not infrequently make a lasting impression upon the minds of business men.

The cleaning of paved streets is necessary for the following reasons: The preservation of the public health; the physical comfort and convenience of the people, and due regard for decent cleanliness and good appearance. Sanitary authorities have for some time held that dirty streets are a prolific cause of disease, and therefore a menace to the public health.

And in the light of recent investigations the conclusions reached by the most eminent scientist in regard to the germ theory of the spread of disease, that nearly all infections or contageous diseases are caused directly or indirectly by specific organisms or their germs, which, being incorporated into or attached to some solid or fluid matter, are carried thereby into the body and to the blood, where they propogate and multiply, causing destruction and death. These conclusions have a very important bearing upon the theory and practice of street cleaning.

When the question of adopting a system of pavements for a municipality is first brought up for consideration it often happens that so much time and energy is devoted to preliminary investigations before a decision is made, that any arrangements for cleaning are neglected until after much construction work has been done. They are then often forced to make a hurried selection of equipment which may later prove to be a failure But, the expenditure having been made, they hesitate to throw it aside. This is one of the reasons why many places are not using the system best suited to do the work effectively. From the sanitary point of view, street dirt may be divided into two physical classes or forms: First, the comparatively fresh, coarse and recently deposited material that reaches the street; and second, the finely comminuted matter, which, when dry, is called street dust.

The views here outlined indicate the importance which is, or should be, attached to the selection of the equipment best suited to secure a frequent and speedy removal of the coarse material before it becomes pulverized and dry, and also to provide some satisfactory method of removing the fine dust that cannot be prevented. In order to do this work effectively one of the best methods that has so far been developed is the use of the hand cleaning patrol system, whereby the men with their carts and brooms are able to pass over their beat several times a day, and promptly, and frequently remove the coarse material, and by this method, if the work is done properly, from ninety to ninety-five per cent. of all the refuse matter and rubbish that finds its way to the street will be removed.

We now come to consider the removal of the fine dust which cannot be prevented, and this is most important. Assuming that this street dust is infected with disease germs,

and that if allowed to remain upon the street it will, by the action of the sun and wind and the pulverizing action of travel, be reduced to a condition of powder so fine and light that it will readily float in the air and be carried by the wind and breezes to a considerable distance, and while thus suspended it may be breathed into the lungs, or deposited upon the bodies of those in the vicinity. It is therefore most dangerous to public health.

For this part of the work the practice of flushing the streets with water under pressure using the street flushing machine is very successful. This is especially true where the proper system of catch basins have been provided to prevent the dirt being carried into the sewers. This is the system and method of doing the work that are in successful operation in the city of Port Arthur.

In the early summer of 1910 the city began the construction of high-class pavements, and by the end of June, 1912, there was laid and open for traffic 81,869 square yards. These pavements consist of five different kinds, viz., sheet asphalt, asphalt block, bitulithic, asphaltic concrete, granatoid or concrete. They are laid on eleven streets and total 3.165 miles. On one of these, which is about a mile in length and paved with asphalt block, there is operated a double track street railway. In cleaning these pavements we find that one man with a Menzie street cleaning cart, using an 18-inch broom, covers an average of 11,695 square yards per day. He wears the ordinary street suit and cap, and has two cans in connection with his cart, when one becomes filled he leaves it at the curb and proceeds to fill the other until the wagon comes to collect it. One man with team and dump wagon collects an average of 8 cubic yards per day, which has to be carted an average distance of one mile.

The sanitary automatic street flushing machine which is used to remove the fine dust, is operated by one man with team. The water for this purpose is taken from stated hydrants.

About thirty minutes are required to fill the tank of the flushing machine and discharge the contents upon the pavements. Each load contains about 480 Imperial gallons and flushes an average area of 2,000 square yards. In the most central part of the city the flushisg is done three times a week, and the remaining portion of the pavements are flushed one and one-half. times each week. No cleaning or flushing is done on holidays or Sundays, and the complete system of catch basins is cleaned five or six times during the summer season. Some extra work is done on Saturday night and on evenings before holidays. In this way the pavements are kept almost spotlessly clean.

The first cost of the equipment which we have in use was as follows:—

One automatic street flushing machine	$1,341.00
One dump wagon	180.00
Seven Menzie street cleaning carts (each with one extra can)	115 50
Seven 18-inch street brooms	7.30
Two street suits for each of seven men	49.00
Total	$1,692.80

The average daily cost for labor to do the work of hand cleaning with brooms and carts, flushing, removing the refuse and cleaning the system of catch basins in connection with the 81,869 square yards of pavement referred to, amounts to $26.00. This shows that under the local conditions as I have stated, and with the equipment referred to, the cost of cleaning one square yard of pavement is .003176 cents per day. Assuming that the streets are free from snow and require to be cleaned in the usual way for 240 days, the cost for the summer season would amount to 7.62 cents per square yard.

It might, however, be said that if the traffic was much heavier, as in very large cities, the cost would be considerably higher, but at present, with the limited area of pavements which we now have, there are 40 earth roads leading to them at various points. These roads, during the wet weather, are a source from which large quantities of mud are carried in upon the pavements by the traffic, and when it is considered that this is most difficult kind of dirt to remove, and that as the area of pavements is increased this source of trouble will become proportionately less, I see no reason to assume that the cost should be materially increased, even with heavier traffic.

KING EDWARD VII. HIGHWAY.

By H. S. Van Scoyoc,*

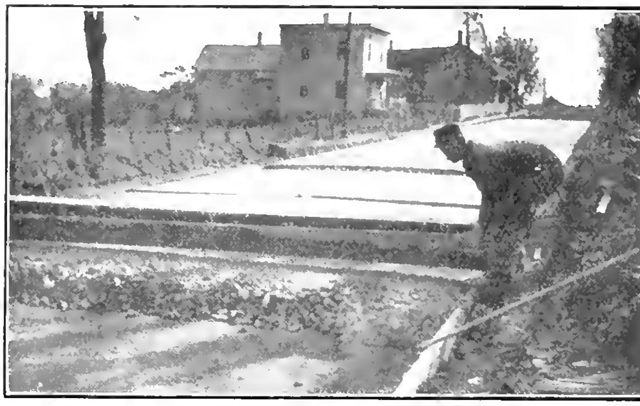
Unquestionable proof of the interest which is being taken in permanent road construction throughout the Dominion is shown by the fact that on the Western coast many miles of the Canadian portion of the Pacific Coast Highway, which will eventually join Mexico with the Yukon, have already been built. In addition, the Western and the Prairie Provinces have completed a number of sections that will form portions of the proposed Across Canada Highway. In Ontario, the completion of the Toronto to Hamilton Road is only a question of time, the portion leading from Toronto through York County having already been built. Quebec has maintained a foremost position in the Good Roads movement, and possibly its most interesting project has been the building of the Canadian portion of the International Highway which will join the city of Quebec on the north with Miami, Florida, on the south. Tenders have recently been requested on that portion of the road which will connect Quebec with Montreal, and it is planned to do as much as is possible of the actual work during the coming season.

That portion of the International Highway which extends from Montreal, Que., to Rouses Point, N.Y., is known as the King Edward VII. Highway, and it had been hoped that this road would be completed during 1912. The very bad season made this impossible, however, and when work was discontinued last fall, approximately one-half of the work remained unfinished. The original plan called for macadam construction, but it was modified to the extent that the portion passing through Napierville was built of concrete. It is the purpose of this article to take up in detail the methods used in the construction of the concrete portion.

The soil in this vicinity is a clay with occasional stretches of sandy loam. Drainage was provided by the construction of open ditches, the bottoms of which were about two feet below the sub-grade. In the village proper, the ditches were filled with large stone, and the stone covered to provide space for sidewalks. In general the grade of the finished roadway follows the surface of the old road so that the amount of either cut or fill was practically negligible. The concrete portion of the road is 16 feet wide, and the excavation was of this width and of such a depth that after thorough rolling with a ten ton roller the sub-grade was parallel to the surface of the finished road, and seven inches below it.

*Inspecting Engineer, Canada Cement Company, Limited. Associate Member American Society of Civil Engineers.

On the sub-grade, prepared in the manner described above, 2 x 7 inch planks were placed on edge 16 feet apart, inside to inside, and held in position by iron pins driven into the sub-grade on either side of the planks. Concrete in the proportion of one part cement, two parts sand and four parts broken stone, mixed in a batch mixer and of a rather wet consistency was then placed to a thickness of seven inches and brought to grade and given the proper shape by means of a strike-board or template. The template was cut to give the road a crown of 2 inches in 16 feet and was made from 2 inch planks. The curved edge was protected by a steel plate and the finished template rested on the side planks as shown in the accompanying photographs. To properly shape the concrete, two men, one at either end, slowly moved the template towards and away from each other, and at the same time, slowly moved it forward. In some cases an up and down motion was used to bed the larger stone in the motar. The template was kept approximately at right angles to the centre line of the road.



Crowning Road with Template, Napierville, Quebec.

The Road Completed.

After the road had been brought to shape no one was allowed to walk on the concrete or disturb it in any manner, and all subsequent work was done from a bridge which was clear of the road and rested upon the side forms. The finishing was done by two cement workers with wooden floats, who worked from the bridge. Great care was used to prevent any depressions in the surface, as it was realized that wear on the surface would be reduced to a minimum if this was accomplished.

Each day's work was covered at night with a tarpaulin and when the concrete was hard enough, the tarpaulins were removed and a covering of two inches of dirt from the sides of the road was placed on the concrete to prevent its drying out too rapidly. It was allowed to remain for two weeks before being removed. The intention had been to sprinkle the dirt each day to keep it damp, but there was so much rain that this was found unnecessary. The rainy weather also kept the sub-grade moist so that it was not sprinkled before the concrete was placed.

Transverse contraction joints were made every twenty-five feet at the time the concrete was placed. The earlier joints were made by means of steel plates 3/8″ thick at the top and 1/4″ at the bottom. The plates were held in position by iron pins driven on either side. When concrete had been placed on both sides of the plates, the pins were withdrawn. After the concrete had set sufficiently the plates were removed and the edges of the joints were rounded to a radius of a quarter of an inch and were tooled down hard and smooth; these joints were afterwards filled with asphaltum.

In the later construction the joint was made in a different manner. A piece of tarred roofing paper was folded around the plate and the whole kept in position as before, but when the concrete had been deposited about three feet beyond the joint, the plate was withdrawn and the concrete tamped against both sides of the tarred paper, closing the space left by the withdrawal of the steel plate. In this way a very narrow joint was made with less trouble and expense, for the filling with asphaltum was avoided, and the steel plate was withdrawn much more readily than when the concrete set up in contact with it. Whenever it was found necessary to discontinue work for any reason, a vertical joint was made. Whenever possible work was stopped at one of the regular contraction joints.

After the concrete had thoroughly hardened, macadam shoulders, four feet in width, were built on either side of the concrete, making the finished roadway twenty-four feet over all. Traffic was not permitted on the road until the concrete had been down for at least three weeks.

DRY DOCK FOR MIDLAND.

A floating drydock and building berth will be constructed by the Midland Drydock Company, Limited, at Midland, Ontario. Among those interested in the enterprise are Mr. James Playfair, Mr. D. L. White, Mr. D. S. Pratt and other residents of Midland. The town has granted a bonus of $25,000 to the company, as it is anticipated that the undertaking will cause the expenditure of large sums of money in the town, give employment to a considerable amount of labor and tend to assist and encourage the marine trade in the port of Midland. The town will issue debentures for the purpose. It has made an agreement with the drydock company and with the Canadian Dredging Company, Limited, by which the plant will be erected for the construction and repair of steel and wooden vessels.

The dock will be built in separate units, the first unit having a length of 150 feet by a beam measurement of 72 feet, and having a lifting capacity of 1,200 tons. The first unit is to be constructed and ready for operation before September 1, 1913, and the second unit by May 1st, 1915. The company will operate their machinery by electric power, purchasing the power from the town, which has agreed to place a fixed assessment on the company's property. Mr. H. Calderwood has prepared the plans for the drydock and building berth.

Midland is in Simcoe County, on Mundy's Bay, an arm of the Georgian Bay, and on the Grand Trunk Railway, 32 miles north-west of Orillia, and 120 miles north of Port Hope. The population of the town is about 4,600.

GREATEST PIER REACTIONS DUE TO LIVE LOADS.

By S. J. Glaser.

In figuring the bearing on foundations of bridge piers, it is necessary, among other things, to find the maximum reaction due to live loads acting on the two adjacent spans.

The accompanying table gives the values of the maximum reactions for any combination of two adjacent spans, varying from 50 to 130 feet in length at five-foot intervals. These spans are most usual for plate girder bridges. The values above the heavy zig-zag line running through the table are for class I., and below for class heavy loading, Dominion Government specifications.

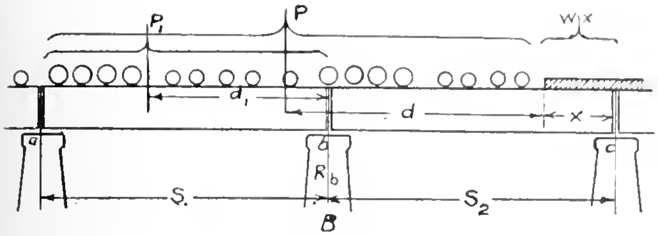


Fig. 1.

To obtain the value of the maximum reaction for any two spans, the larger span should be looked for in the first or last vertical column, depending respectively on whether class I. or class heavy loading is used.

A series of curves can be platted from the values found in the table and the greatest pier reactions for intermediate spans can be obtained. It will also be found that the lower part of the curves are straight lines, and when these lines are produced values sufficiently correct for spans less than 50 feet can be mechanically obtained. Such span lengths are frequently used for steel viaduct bridges.

The values in the table may be enterpolated for intermediate spans in a horizontal direction for the variations are proportional.

The method of obtaining the greatest pier reactions due to live load is as follows: The load on any pier is the sum of the reactions at the end of the adjoining spans. In Fig. 1 the reaction of pier B, due to live load, is equal to the sum of the right reaction of span ab and left reaction of span bc.

The criterion of loading giving the greatest value of this sum is similar and is derived in the same way as that for maximum floor beam loading.

Letting P, (Fig. 1) be the load on the span ab, d, the distance of its centre of gravity to the right end of the span, and letting P be the sum of the concentrated loads of the typical consolidation locomotives on both spans ab and bc, and d the distance of its centre of gravity to the head of the train, whose weight is w pounds per linear unit. The total live load on the span is $P + wx = W$. Let Rb be the combined reactions of the two adjoining spans, of lengths S_1 and S_2. An expression for Rb can be obtained. Placing the dirivative of this expression equal to zero, also substituting for $P + wx = W$ we get

$$\frac{W}{P_1} = \frac{S_1 + S_2}{S_1} \qquad (1)$$

or the loads should be proportional to the lengths of the spans is the criterion to make the value of Rb a maximum.

When $S_1 = S_2$ the criterion becomes $W = 2 P_1$ (2)

Care must be used in applying these criterions. Since the concentrated loads are not uniform the loading to give a maximum should be so apportioned that a heavy driver is at b and as large a load brought on the two adjoining spans as possible.

In figuring the reactions from a moment diagram it may be arranged more conveniently as follows: Let Mc equal the moment of the loads in both spans about c and Mb equal the moment of the loads in span S_1 about b, then

$$Rb = \frac{M_1 S_1 - Mb (S_1 + S_2)}{S_1 \times S_2} \qquad (3)$$

This becomes $Rb = \dfrac{Mc - 2 Mb}{S}$ (4)

for two equal spans of length S.

For two unequal spans with train running in either direction there will be two maximum reactions. It can easily be shown from (3) that the greater maximum value of Rb will be obtained when S_2 is the smaller span and train running in direction shown in Fig. 1.

Table Showing Maximum Pier Reactions Due to Live Load for One Rail for Class I. and Class Heavy Loading, Dominion Government Specifications, Values Given in Kips.

Larger Span	Maximum Pier Reaction — Class I — Dominion Government Specifications																	
	130	125	120	115	110	105	100	95	90	85	80	75	70	65	60	55	50	
	341.0	335.4	329.7	324.1	318.5	313.9	307.3	301.6	296.0	290.3	284.8	279.2	273.6	267.9	262.3	256.7	251.1	130
50	159.1	331.1	325.5	319.8	314.2	308.6	302.9	297.3	291.6	286.1	280.4	274.8	269.1	260.5	257.8	252.3	246.7	125
55	170.8	177.0	321.2	315.5	309.9	304.3	298.6	293.0	287.4	281.7	276.1	270.4	264.8	259.2	253.5	247.8	242.2	120
60	180.3	187.2	193.9	311.7	306.0	300.5	294.6	289.0	283.3	277.6	271.9	266.2	260.5	254.8	249.1	243.3	237.5	115
65	189.0	195.8	202.5	209.1	301.9	296.2	290.6	284.9	279.2	273.5	267.8	262.1	256.4	250.7	244.9	239.2	233.4	110
70	197.4	204.0	210.6	217.2	223.7	291.8	286.1	280.4	274.7	269.0	263.3	257.6	251.9	246.2	240.5	234.7	228.9	105
75	205.5	212.0	218.4	224.8	231.0	237.3	281.7	276.0	270.3	264.6	258.8	253.1	247.3	241.5	235.6	229.8	223.9	100
80	212.5	219.0	225.5	231.8	238.1	244.3	250.5	271.2	265.5	259.7	254.0	248.2	242.5	236.7	230.1	224.9	219.0	95
85	219.2	225.4	231.7	238.0	244.3	250.7	256.7	262.9	260.1	254.4	248.7	242.9	237.1	231.3	225.5	219.6	213.7	90
90	225.5	231.8	238.0	244.2	250.3	256.4	262.5	268.5	274.6	249.1	243.2	237.4	231.4	225.5	219.5	213.6	207.7	85
95	231.2	237.4	243.7	249.8	255.9	262.0	268.1	274.2	280.2	286.3	237.3	231.5	225.6	219.6	213.6	207.5	201.3	80
100	236.4	242.5	248.7	254.8	261.0	267.1	273.2	279.3	285.3	291.3	297.4	224.8	218.9	212.9	206.9	200.8	194.7	75
105	241.6	247.7	253.8	259.9	266.0	271.9	278.0	284.0	290.0	296.0	302.0	308.0	211.9	205.7	199.5	193.2	187.1	70
110	246.4	252.5	258.5	264.6	270.7	276.7	282.7	288.7	294.7	300.7	306.7	312.7	318.7	198.1	191.8	185.5	179.1	65
115	250.7	256.8	262.9	269.0	275.0	281.0	287.1	293.1	299.0	305.1	311.0	317.2	323.0	328.9	183.7	177.3	170.8	60
120	255.6	261.6	267.6	273.5	279.5	285.5	291.4	297.4	303.3	309.3	315.2	321.3	327.1	333.1	339.0	167.7	161.8	55
125	260.4	266.3	272.1	278.2	284.1	290.0	296.0	301.9	307.9	313.8	319.8	325.7	331.7	337.6	343.6	349.5	150.7	50
130	265.1	271.0	276.9	282.8	288.8	294.7	300.6	306.5	312.5	318.4	324.3	330.3	336.2	342.1	348.1	354.0	359.9	Larger Span
	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	
Class Heavy	Maximum Pier Reactions — Class Heavy — Dominion Government Specifications																	Class I

CANADA'S STEEL INDUSTRY

The production of steel ingots and castings in 1911 was 882,396 tons, as compared with 822,284 tons in 1910 and 754,719 tons in 1909. In 1911 the production of open-hearth ingots was reported as 651,676 tons; Bessemer ingots, 209,817 tons; direct open-hearth castings, 20,163 tons, and other steels, 740 tons. The total increase in production over 1910 was 60,112, or a little over 7 per cent. The production during the five years, 1907-1911, follows:—

	1907. Tons.	1908. Tons.	1909. Tons.	1910. Tons.	1911. Tons.
Ingots — Open-hearth (basic)	459,240	443,442	535,988	580,932	651,676
Bessemer (acid) ...	225,989	135,557	203,715	222,668	209,817
Castings—Open-hearth	20,602	9,051	14,013	18,085	20,163
Other steels	1,151	713	1,003	599	740
Total ...	706,982	588,763	754,719	822,284	882,396

Statistics showing the quantities of the principal materials used in steel furnaces were obtained for the first time for the year 1910, and it may be of interest to refer to these here. The total quantity of pig iron used in steel furnaces during 1911 was 700,679 tons, of which 640,636 tons were produced by firms reporting, and 60,043 tons purchased. The quantity of ferro-alloys used was 21,359 tons purchased. Scrap, etc., was used to the extent of 278,797 tons, being 198,482 tons produced by the firms reporting, and 80,315 tons purchased. Ores used included 829 tons of manganese ore and 42,892 tons of iron ore, while 130,270 tons of limestone or dolomite flux were used and 8,067 tons of fluorspar. In Ontario a little over 662 million cubic feet of natural gas were used, while in Nova Scotia coke oven gas was used at Sydney, of which a record of quantity is not obtained.

In 1910 the total quantity of pig iron used in steel furnaces was 690,913 tons, of which 601,219 tons were produced by firms reporting, and 89,694 tons purchased. The quantity of ferro-alloys used was 8,143 tons purchased. Scrap, etc., was used to the extent of 211,453 tons, being 140,913 tons produced by the firms reporting and 70,540 tons purchased. Ores used included 1,317 tons of manganese ore and 30,332 tons of iron ore, while 144,110 tons of limestone or dolomite flux were used and 7,461 tons of fluorspar. In Ontario a little over 600 million cubic feet of natural gas were used.

Statistics of the production of steel ingots and castings since 1900 are given in the following table:—

Calendar year.	Short tons.	Calendar year.	Short tons.
1900	26,406	1906	639,396
1901	29,214	1907	706,982
1902	203,881	1908	588,763
1903	203,296	1909	754,719
1904	166,381	1910	822,284
1905	451,863	1911	882,396

Mr. J. McLeish, chief of the division of mineral resources and statistics, shows that while complete statistics of the production of rolled products and of manufactured steel were not available, returns from seven of the largest producers showed a production of blooms, billets, slabs, etc., of 737,261 tons, of which 719,514 tons were used by the producer for further manufacture, and 17,747 tons sold to other rolling mills.

The production of rails was 309,760 tons; of rods, 85,811 tons; of bars, 109,623 tons, and of other rolled products, 65,076 tons. The production of steel rails in 1910 was returned as 300,762 tons, and in 1909, 377,642 tons.

The production of finished rolled iron and steel in Canada from 1909 to 1911, as ascertained and published by the American Iron and Steel Association, was as follows, in long tons:—

	1909.	1910.	1911.
Rails	344,830	366,465	360,547
Structural shapes and wire rods	74,136	80,993	76,617
Plates and sheets	36,241	26,642	14,833
Nail plate, merchant bars, and all other finished rolled forms	207,534	265,711	323,427
Total	622,741	739,811	775,424

Since 1896 a total of $16,785,827 has been paid by the government of Canada in bounties for the production of iron and steel.

The total value of iron and steel goods, including agricultural implements, automobiles and bicycles, exported from Canada during 1911 was $9,907,281, as compared with a value of exports in 1910 of $7,895,489, and in 1909 a value of $7,172,413. Of the total exports in 1911, stoves, gas buoys, castings, machinery, and hardware contributed a total valuation of $1,242,006; pig iron, $271,968; scrap iron and steel, $54,618; steel and manufactures of steel, $769,692; agricultural implements, $6,281,929, and automobiles and bicycles, $1,287,068. Particularly large increases are noted in the exports of agricultural implements and of automobiles and bicycles.

The total value of the imports during the fiscal year ending March, 1911, was $85,319,541, as compared with the valuation of imports in 1910 of $59,952,197, and $40,393,431 during the fiscal year 1909. These imports include all classes of iron and steel goods manufactured, as well as those of a crude form. In many cases the imports of manufactured goods are given only in dollars, so that the total tonnage of imports cannot be estimated. In the case of most of the cruder materials, however, the quantities are given, and a compilation of these shows a minimum importation of iron and steel during the fiscal year ending March, 1911, of 1,284,401 tons, as compared with 915,425 tons in 1910 and 565,734 tons in 1909.

The record shows an importation in 1911 of ingots, blooms, billets, puddled bars, etc., of 48,395 tons; scrap iron and scrap steel, 53,824 tons; plates and sheets, 205,690 tons; bars, rods, hoops, bands, etc., 183,865 tons; structural iron and steel, 345,350 tons; rails and connections, 36,690 tons; pipe and fittings, 28,831 tons; nails and spikes, 3,099 tons; wire, 64,850 tons; forgings, castings, and manufactures, 24,523 tons.

The total value of the 1,284,401 tons imported was $33,766,865, or an average value per ton of $26.29. Other iron and steel goods of which the weights are not recorded were imported to the value of $51,552,679, making up the total value of $85,319,541.

A very large proportion of these imports is derived from the United States, and it may be of interest here to quote from the records published in the "Commerce and Navigation of the United States," showing the exports of iron and steel goods from that country to Canada.

According to this authority there was exported to Canada from the United States during the twelve months ending June 30th, 1911, 821,526 tons of iron and steel goods, valued at $25,544,421, together with other iron and steel goods of which the weight is not given, valued at $38,738,575, or a total value of $64,282,996.

During the twelve months ending June 30th, 1910, the corresponding exports to Canada were 574,807 tons, valued at $19,673,740, together with other iron and steel goods to the value of $28,153,628, or a total value of $47,827,368. Iron ores are not included in either case.

The imports of some iron and steel products of which the weights are available follow:—

Material.	Twelve months ending March.	
	1910.	1911.
	Tons.	Tons.
Pig iron	159,506	270,102
Ferro-products and chrome steel	15,153	19,182
Ingots, blooms, billets, puddled bars, etc.	36,819	48,395
Scrap iron and scrap steel	28,797	53,824
Plates and sheets	200,575	205,690
Bars, rods, hoops, bands, etc.	117,159	183,865
Structural iron and steel	195,748	345,350
Rails and connections	55,183	36,690
Pipes and fittings	16,705	28,831
Nails and spikes	3,476	3,099
Wire	68,211	64,850
Forgings, castings and manufactures	18,003	24,523
Total	915,425	1,284,401

ENGINEERING AND THE BEAUTIFUL.*

It is an idle platitude to state that the present is an age of specialization, for no man can say as Lord Bacon did: "I will take all knowledge to be my province." Even the most versatile engineer can attempt to master but one branch of his profession, although collectively the engineers' achievements have changed the whole aspect of modern civilization. If we cast our minds back to-night to, say, the new year 1813, what a fascinating kaleidoscope it makes, especially to us on the Pacific slope, when we try to realize what has been accomplished in that country of progress, and then contrast the material progress that had been accomplished up to that time from the days when the architects Ictinus and Callicrates collaborated with Phidias, to produce the beautiful Parthenon, one only of many beautiful structures which the Greeks so magnificently created more than two thousand years ago.

The engineer of the past century has been a powerful and beneficial revolutionist, and his successful revolutions have instituted many reforms that have accomplished more for the well-being of the human race than most of the boasted achievements of contemporary wars and political agitations.

But, with all our progress, proud though ye may be, is it not well to remember that because the work of the engineer forms a vital and integral part of the life of any community, we should all pay some regard to the creation of beauty and the influence of engineering upon the minds of the people.

Ruskin's well-known aphorism on architecture might have some meaning for us as engineers; he defined it, you may remember, as "the art which so disposes and adorns the edifices raised by man, for whatsoever uses, that the sight of them may contribute to his mental health, power and pleasure."

Engineers are usually regarded as estimable utilitarians who, by their works, enable continents to be crossed in comfortable cars, who control rivers, build harbors and docks, develop water powers by converting the rain and snow of the upper mountains into electrical energy, do much toward conquering time and space and invent wonderful machines for the general advancement of the people, but who are not primarily concerned with beauty or the creation of beautiful objects.

In olden days engineering and architecture were practised by the same individuals. The old Roman engineers, designers of the Pont-du-gard and the Claudian aqueduct, produced great engineering works that are among the finest architectural remains of that great race. In the rennaissance period were not the great artists Michael Angelo, Leonardo-da-Vinci and Palladio great both in architecture and engineering? Modern engineering, though, with all its mighty achievements, is still in the early pioneer stage, while the traditions of architecture are hoary with the experience of ages.

Engineering structures in steel have been accused of being purely utilitarian, and even William Morris denounced the famous and, as many of us think, beautiful Forth Bridge as "that supreme specimen of all ugliness." But Morris did not understand as the designers did, that their "object had been to arrange the leading lines of the structure so as to convey an idea of strength and stability," and that object they had considered the highest art. On the other hand, a famous artist—Alfred Waterhouse—writing to Sir John Fowler after the bridge was completed said:

"The simple directness of purpose with which it does its work is splendid, and invests your vast monument with a kind of beauty of its own, differing though it certainly does from all other beautiful things I have ever seen."

We cannot yet expect that a well-designed steel structure will be properly appreciated as stone structures have been. Let us remember that the Parthenon was built during Pericles time, when Greek art and literature reached its proudest zenith, but that great period was preceded by centuries of strenuous effort and experience; while steel structures belong but to yesterday, and many new and more perfect types remain to be evolved in the future. It is therefore unfair to apply the same standards of criticism to a modern steel structure as would be applied to one of wood, brick or stone.

The evolutionary process that is apparent in the design of modern steel structures, to use Herbert Spencer's line of progress in organic evolution is from "simplicity to complexity of structure, and from obscure complexity to a defined simplicity of function," and this "simplicity of function" should be the prevailing note in all well-designed structures to-day. Michael Angelo maintained that an architect should have a knowledge of anatomy; cannot we also boldly assert that to those who examine iron and steel structures from an aesthetic point of view, that a knowledge of their anatomy and of the functions of their various parts is essential?

What I really want to urge is that it is essential to-day that there should be greater co-operation between engineers and architects. Engineers have no right to load their structures with architectural decoration that they do not understand. "I love a sufficient man," said Emerson, "he meets my needs," but we cannot to-day, in the infinite variety of duties an engineer is called upon to perform, produce the "one sufficient man" for a great engineering structure. It takes the engineer the greater part of a busy life to master even one branch of the profession, and it takes the whole of an architect's life to understand his art. I am, therefore, advocating the co-operation of engineers and architects in the design of engineering works; these works are primarily for the use of the community, and in many cases, such as in the building of great masonry dams which may last for many centuries, we have no right to inflict ugliness upon the present and coming generations, especially as a beautiful design generally costs no more to construct than an ugly one, and not infrequently costs less.

One almost hesitates to suggest, in these days when the young engineering student's college curriculum is so crowd-

* An address delivered at the year end dinner of the Pacific North-West Engineering Society, Seattle, January 4th, 1913, by G. R. G. Conway, M.Inst.C.E., M.Am.Soc.C.E., M.Can.Soc.C.E.

ed, that a part of his training should be to acquire some knowledge of classic architecture. To appreciate the proportions of an old Greek temple is part of a liberal education, and in after life it might prevent the engineer from placing meaningless ornament upon his designs, and lead him in all humility to seek advice from the members of his brother profession.

That versatile and eminent English engineer, the late Sir Benjamin Baker, used to tell a story of how, when he was very young he thought he could do without architects, and how he had carried out what he thought was some very pretty work. There had been scrolls and columns and arches in iron work, and John Ruskin said when he had seen it that he wished that he had been born a blind fish in a Kentucky cave!

To-day, I think, we can point to many fine works that have been constructed on the American continent and in Europe, where engineering works have a magnificent and beautiful appearance. There is great scope in the building of masonry and concrete dams, and this has been well carried out in the Croton Dam for the water supply of New York, and in the dams for the supply of water to the cities of Liverpool and Birmingham. We see the co-operation of engineers, sculptors and architects in such beautiful bridges as the Pont Alexandre, in Paris, and in the great terminal railway stations of the Pennsylvania Railroad, the New York Central, the terminal at Washington, and the Orleans station at Paris; in power houses, Niagara and elsewhere, and in the general progress of town planning; and I might also further point out, the possibility of beautiful designs in reinforced concrete structures is being thoroughly appreciated.

In many cases, an engineer, be he the servant of a government, municipal or private corporation, must of necessity attain results by economy in design. In our new and developing towns on the Pacific Coast, it is not possible to do what is being done in older established communities. None of us believe that cedar poles with dozens of power wires strung on them along a public street are beautiful objects—unless seen in an etching by Whistler—but the public must always remember they belong to a transitional epoch when money is needed for necessary development, and distant shareholders have a right to the modest dividends they obtain from electric railway and power undertakings. The future, though, with the great growth of business, will make it necessary for all interests to place such wires underground, and then we have what is right from an engineering point of view, assisting in promoting the beauty of our towns.

Why should not even the humblest railway station be a beautiful object? We no longer believe in Ruskin's fierce denunciation of architectural railway stations, and in these days of constant travel, the comfort and beauty of a railway terminal is a delight to travelling man. Why cannot we have beautiful designs for the buildings and chimneys of a steam power plant, for a water tower, for all our bridges, for service reservoirs and valve houses? We should, though, in every case let these structures express by their design their meaning, stating plainly without pretension what they represent. We do not want a railway terminal to look like a temple for the worship of Minerva, or a steam plant chimney to resemble Cleopatra's needle.

Engineering touches every phase of our life, and it is clearly our duty to do all we can, not only to assist the material prosperity of our country, our state or province, but to contribute to all those things that elevate man outside of the strenuous every-day struggle for existence into a sphere that will enable him to appreciate the higher arts, and in that work the engineer can do his share in proving that the useful can also be the beautiful.

CANADIAN POTTERY

The pottery made from Canadian clays has been, hitherto, chiefly of the common grades, such as flower pots, jardinieres, crocks, jars, churns, etc. A number of potters make a higher grade product of stoneware, but the majority of these use imported clays. Sanitary ware is made at St. Johns, Que., and other points; but the raw material including clays and feldspar, is nearly all imported.

The total value of the production of pottery and clay sanitary ware in 1911, according to returns received, was $439,264, of which it is estimated that a value of $336,771 is attributable to imported clays. The value of the production reported in 1910 was $250,924, and in 1909, $285,285.

The total imports in 1911 were valued at $2,516,536, as compared with a value of $2,283,116 in 1910. These imports are subdivided into eight classes, and in 1911 include: brown or colored earthenware, etc., $52,100; C.C. or cream colored ware, decorated, printed or sponged, etc., $184,291; demijohns, churns, or crocks, $4,933; tableware of china, porcelain, white granite, etc., $1,718,582; china and porcelain ware, N.O.P., $62,025; tiles or blocks of earthenware or stone prepared for mosaic flooring, $123,203; earthenware tiles, N.O.P., $154,351; manufactures of earthenware, N.O.P., $217,051.

Great Britain is the principal source of the imports of this class of products, but quite large supplies are also obtained from the United States, Germany, France, Austria-Hungary, Japan, Belgium, and other countries.

Although there has as yet been no actual commercial production of china-clay or kaolin in Canada, the development of kaolin deposits in the township of Amherst, Ottawa county, and the construction of a washing or refining plant at St. Remi d'Amherst, are worthy of note.

The present operators are the Canadian China Clay Company, with a capital of $250,000. Mr. John C. Broderick, St. Remi d'Amherst, is mine manager, and Mr. Jas. G. Ross, B.Sc., consulting engineer.

The plant for refining the clay is situated two miles from St. Remi d'Amherst and seven miles from Huberdeau station, the terminus of the Canadian Northern Quebec Railway, 94 miles north-west of Montreal.

Development work was begun by the present operators in June, 1911, and the washing plant completed in April of 1912.

The clay is mined by digging, no drilling or blasting being necessary, trammed 600 feet to the plant, washed free from grit and allowed to settle. After the filter presses have extracted the surplus moisture, it is dried in the open air in stacks.

Dry kilns are being built for drying in the winter and wet seasons. After drying it will be pulverized and bagged for shipment. It is expected that an immediate market will be found in the demand of the Canadian paper mills.

The imports of china-clay, ground and unground, into Canada during the twelve months ending December 31st, 1911, were valued at $125,768, as against a value of $142,125 in 1910, and $100,066 in 1909, thus indicating to some extent at least the present actual demand for this product. The imports of earthenware and chinaware, however, valued at $2,516,436 in 1911, and composed chiefly of tableware of china, porcelain, etc., show the possibilities in the development of industries utilizing china-clays, suggests Mr. J. McLeish, chief of the division of mineral resources and statistics, in a recent report.

Kaolin or china-clay is also in considerable demand in the United States, the imports into that country in 1910 being valued at $1,593,472.

THE FILTRATION PLANT OF THE MONTREAL WATER AND POWER COMPANY AT MONTREAL, QUEBEC.

The Montreal Water and Power Company furnishes water to the outlying wards of the city of Montreal and to the cities of Westmount and Maisonneuve, and the town of Outremont, comprising in all, a population of about 250,000.

The water supplied consists of a mixture of St. Lawrence and Ottawa River water and is subject to marked seasonal changes in character. Normally, it is quite clear and free from turbidity or color. The alkalinity averages about 95 parts per million and the permanent hardness for incrustants about 20 parts per million. For a short period in the spring and autumn it becomes turbid and considerably colored. The bacterial content is never high, in fact it is abnormally low for water from a river of this character. A sterilizing plant has been in operation for over two years, and the water supplied has been satisfactory from a bacteriological standpoint to the Provincial Board of Health.

However, owing to an ever-increasing demand for filtered and colorless water, the company decided to install the present plant.

The filtration plant, which is of the so-called rapid mechanical gravity type, is situated near the main pumping station on the banks of the St. Lawrence River, at the southwestern city limit. It comprises low lift pumps, settling and coagulating basins, filter beds, clear water basin, wash water pumps, blowers, a storage tank for air and wash water, chemical mixing tanks and complete apparatus for handling sulphate of alumina and hypochlorite, a completely equipped chemical and bacteriological laboratory and a large chemical storage room.

All pumps, blowers, agitators and other machinery in the plant are operated by electricity and are all provided in duplicate.

The capacity of the plant is 25 millions of Imperial gallons per day, but provision has been made throughout for the extension when required to a capacity of 42 millions per day.

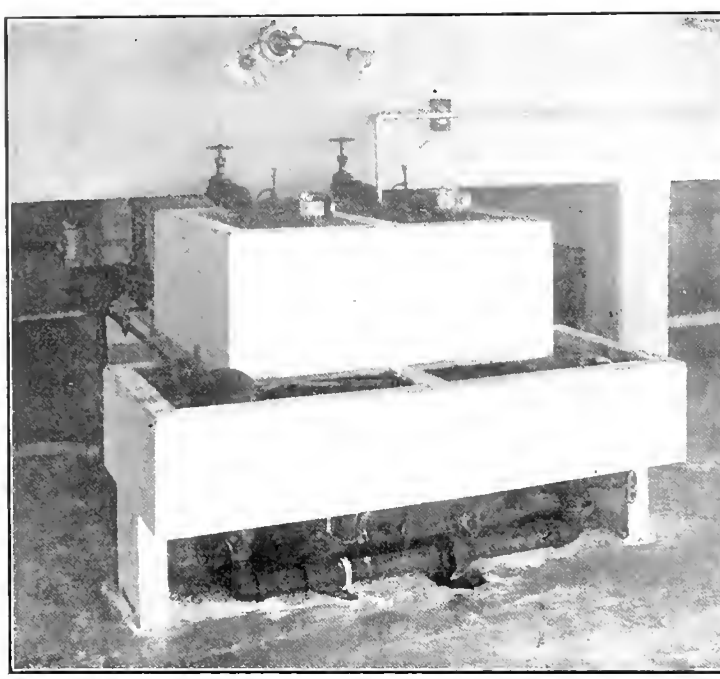
The river water flows by gravity into a suction well thirty feet in diameter and is pumped from this into the coagulating basin, from which it flows by gravity to the filters, through the filters to the clear water basin, and thence to the high lift pumps, which deliver it to the distribution system. This is shown in the diagram on the following page.

The raw water pumps are electrically driven turbine or centrifugal pumps operating against a total head, including suction and friction, of thirty feet, and discharge into a 60-inch steel main connecting to a concrete flume leading to the sedimentation and coagulating basins. At the inlet end of the basin is a float chamber, where the flow of water is automatically regulated by floats which operate throttle valves on each of the pumps. This is accomplished by means of hydraulic valves, the floats merely opening or closing small pressure valves which control the hydraulic valves.

The Building of the Filtration Plant, Montreal Water and Power Company.

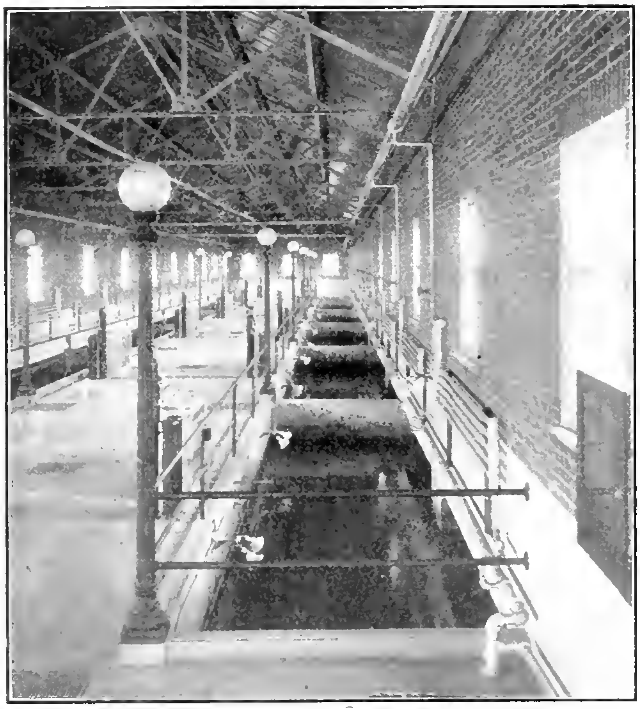
Settling Basins.—These are in duplicate, each holding about 500,000 Imperial gallons. They each measure 110 feet by 48 feet 6 inches in plan and are divided into two halves by longitudinal baffle walls which cause the coagulated water to pass the length of each basin twice before reaching the skimming weir at the outlet end. The basins are covered by a concrete roof of the beam and slab type, carrying about three feet of earth for protection from frost.

The Filters.—Coagulated and settled water is conveyed into the filter house by a concrete flume with connections to each of the 15 units. The top of this flume forms the floor of the operating gallery, and below it is the pipe gallery. Each filter unit has an area of 696 square feet, and is divided into two equal parts by a central gutter of concrete to which are connected eight lateral gutters of cast iron, four on each side. The filtering material consists of 9 inches of gravel graded in size from ⅛ inch to ¾ inch, upon which rests 27 inches of sand having an effective size between 0.4 mm. and 0.65 mm. and a uniformity coefficient ranging from 1.5 to 1.8. The rate of filtration at which the plant is operating and for which it was designed is 1.67 gallons per minute per square foot of filtering area. The strainer system is the New York Continental Jewell Company's standard type, consisting of an elliptical cast iron header with a section equal in area to an 8-inch pipe and manifolds of 1¾-inch lateral pipe spaced on six-inch centres. These laterals are drilled and tapped on their top



View Showing Orifice Boxes.

sides at intervals of six inches to receive the strainers. The elliptical header pipes are also drilled and tapped for a double row of strainers. This arrangement provides four strainers for each square foot of filtering area. The strainer heads are mounted on ⅝ inch tubes extending into the lateral pipe to form a water seal and effect a proper distribution of air while washing. Each strainer contains thirty-three one-sixteenth-inch holes. The system, when assembled in place, is embedded in concrete so as to leave only the upper portions of the headers and strainer caps exposed.



View of Filter Gallery of the Filtration Plant.

The wash water main is 30 inches in diameter with 16-inch branch connections to each filter. The water is supplied under pressure from the storage tank, passing up through the bottom of each header of the strainer system, out through the laterals and up into the filtering material. The main air line is 12 inches in diameter with 8-inch connections to each filter.

The piping is carried above the wash water gutters and is connected at two points in each header by a 4-inch vertical pipe. The filtered effluent passes into the clear water basin through rate controllers of the Venturi type and 14-inch down-draft tubes, one for each unit. The valves for controlling all the connections to and from the filter units are hydraulically operated, double gatevalves and are controlled from an operating table, one of which is provided for each unit. The pistons of the valves are operated by water under pressure from the company's distribution system.

Telescopic Storage Tank.—The distinctive feature of this plant is the large telescopic storage tank for the supply of wash water and air under pressure for washing the filter beds. This tank is built in two sections; the upper one telescoping into the lower one after the manner of a gas holder.

For washing one filter unit, water must be delivered at the rate of 5,000 gallons per minute for about three minutes, and pumping capacity to this extent would be necessary if no storage were provided. This would require a motor-driven pump operating at 125 h.p. for short periods, and would permit of the washing of only one unit at a time. With the storage capacity provided in the tank a pump of small capacity operated continuously by a 15 h.p. motor is sufficient.

Further, two filter units may be washed simultaneously without affecting the power consumption. As the power for operating the plant is purchased at a flat rate based on the peak load, the great economy of this arrangement is abvious. The conditions governing the supply of air for agitating the beds are precisely the same, a 5 h.p. motor and blower being sufficient as against 60 h.p. required without the intervention of storage. There is the further advantage that the air and water are supplied under more nearly uniform conditions than would be possible by direct supply from pumps or blowers. In order to compensate for varying levels of water in the tank, an automatic pressure regulator is provided at the outlet. The air is maintained at a constant pressure by the loading of the top of the inverted tank with a slab of concrete about three feet in thickness.

The small pumps and blowers supplying the tank are automatically controlled by floats and require practically no attention from the operators.

Chemicals.—The chemical storage room and the appliances for mixing and preparing the sulphate of alumina and hypochlorite solutions are situated on the floor above the machinery room and the prepared solutions delivered by gravity to their points of application. The alum is dissolved in rectangular tanks with perforated bottoms open to the storage tanks below. The solution thus prepared is conducted through lead pipes to the suctions of the low lift pumps, an arrangement which ensures a thorough mixing of the alum with the raw water.

The hypochlorite is fed to the mixing tanks through grinders which deliver the material in a finely divided state, ensuring a thorough mix.

Both alum and hypochlorite are provided with motor driven agitators to maintain a uniform density of the solution.

The flow of these solutions is regulated by means of orifice boxes, in which a constant level is maintained and from which the solution is fed through graduated orifices of hard rubber.

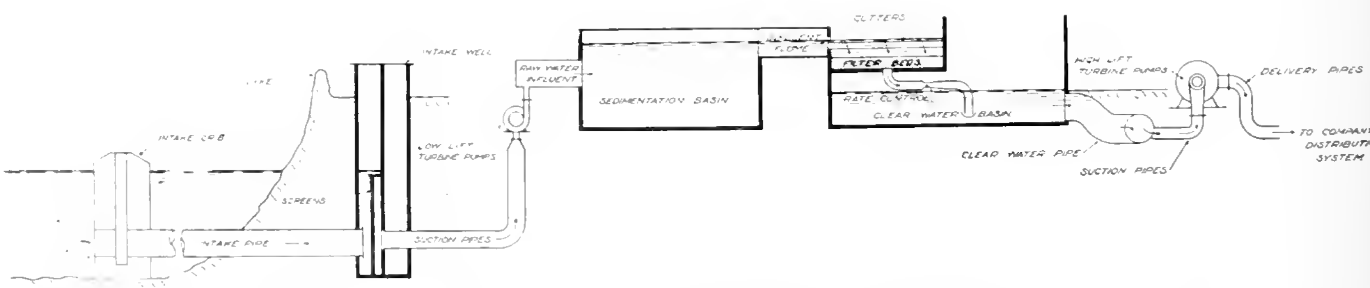


Diagram Showing Course of Water Through Filtration Plant, Montreal Water and Power Company.

The plant has now been in successful operation for about six months and is delivering clear, colorless and practically sterile water.

The plant was designed and constructed for the Montreal Water and Power Company, under the supervision of Mr. F.

H. Pitcher, general manager and chief engineer, and Mr. Wm. H. Sutherland, assistant engineer of the company.

The contractors were Messrs. Laurin and Leitch, of Montreal, and the entire mechanical equipment, detailed plans, etc., were furnished by the New York Continental Jewell Filtration Company, as sub-contractors.

The mechanical operation of the plant is in charge of Mr. W. G. Dryden, superintendent, and the sanitary engineer is Mr. J. O. Meadows, formerly sanitary engineer of the Provincial Board of Health, Quebec.

STEAM BOILER EXPLOSIONS.*

By William H. Boehm.

Every year there occur in the United States between 1,300 and 1,400 serious boiler accidents, of which 300 to 400 are violent explosions. These accidents kill between 400 and 500 persons, injure 700 to 800 more, and destroy more than a half million dollars worth of property. These disasters have but scant respect for boiler types for they occur with water-tube boilers, although with them violent explosions occur less frequently than with fire-tube boilers. They also occur with low-pressure boilers.

It is of the utmost importance that boilers be carefully designed, that the stresses to which they are subjected be accurately computed, that suitable material be specified, that the material be critically examined for flaws or defects, that specimens of the material be tested to determine its strength, that no abuse of the material be allowed in the process of constructing the boiler, and that the completed boiler be subjected to a thorough inspection and a hydrostatic test before being put into service.

The stress in the girth seams of a boiler may be obtained by the formula

$$S = \frac{r\,p}{2\,t}$$

in which

S = Stress per square inch to which the material is subjected;
r = Radius of the boiler;
p = Steam pressure carried;
t = Thickness of the shell.

The formula means that if we multiply the shell radius by the steam pressure, and divide the product by twice the shell thickness, the result will be the stress in pounds per square inch to which the material in the girth seams is subjected.

The stress in a side seam of a boiler may be obtained by the formula

$$S = \frac{r\,p}{t}$$

which means that if we multiply the shell radius by the steam pressure and then divide the product by the shell thickness, the result will be the stress in pounds per square inch to which the material in a side seam is subjected.

An inspection of these formulas show that the stress in a side seam is just twice as great as the stress in a girth seam. It is for this reason that the side seams are usually double riveted when the girth seams are only single riveted.

The pressure required to rupture the shell of a cylindrical boiler is given by the formula

$$P = \frac{s\,t}{r}\,e$$

in which

P = Bursting pressure in pounds per square inch;
s = Tensile strength of the material in the boiler;
r = Radius of the shell;
e = Efficiency of the riveted side seam.

Stated in words the formula means that if we multiply together the tensile strength of the material, the thickness of the shell, and the efficiency of the riveted side seams, and then divide the product so obtained by the radius of the shell the result will be the steam pressure at which explosion will occur.

If it so happens that the efficiency of the girth seam is too low by reason of improper design, then the girth seam may fail instead of the side seam, in which case the bursting pressure is given by the formula

$$P = \frac{2\,t\,s}{r}\,e'$$

which means that if we multiply together twice the thickness of the shell, the tensile strength of the material, and the efficiency (e') of the girth seam, the result will be the steam pressure at which explosion will occur. The girth seam is not likely to fail before the side seam, because to do so the efficiency of the girth seam would have to be less than half that of the side seam a weakness that should not exist in a boiler of proper design and construction.

The formulas expressed herein give the pressure at which the boiler will explode and not the pressure at which it may be safely operated. It is usual in boiler practice to fix the allowable working pressure for a new boiler at one-fifth the computed bursting pressure and to decrease the pressure allowance as the age of the boiler increases.

This is equivalent to saying that the factor of safety applied to a new boiler is usually not less than five. The term "factor of safety," is often misunderstood and a better name would be "factor of ignorance," as it is as much a factor of ignorance as it is a factor of safety.

Take, for example, the case of a new boiler operated with the safety valve set at 100 lb. If the computed bursting pressure be 500 lb., then the assumed factor of safety is five. The assumption, however, is based upon the tensile strength stamped in the plate by the maker and this strength is only true of that particular part of the plate from which the test specimen was cut and not necessarily of any other part.

As a matter of fact it is current practice to cut the test specimen from the outer edge of the plate and the strength there is almost invariably greater than the strength at the centre of the plate. The reason is that after liquid steel is poured into a mold its solidification in forming an ingot proceeds in much the same manner as does the solidification of water in forming a block of ice. That is to say, the impurities and gases are driven toward the centre.

Boiler plates made by the rolling of such an ingot will, therefore, have more impurities and less strength at the centre of the plate than at the outer edges, and this variation in strength is very considerable. Then, too, the stress at which the elastic limit of the material is reached is little more than half the stress at which rupture occurs.

Besides our ignorance of the dependable strength in all parts of the plate, there is also our ignorance of the character of the workmanship in the boiler. We cannot be certain that all rivet holes come fair, or that incipient cracks

* Abstract of a lecture delivered at Cornell University before the state branch of the American Society of Mechanical Engineers.

have not been set up by an abuse of the material during the process of construction. It is seen, therefore, that factors of safety are really made up of two parts—one part a true factor of safety, the other a pure factor of ignorance.

Boiler explosions may be attributed to improper installation, or incompetent or careless operation.

Improper construction may consist: of unsuitable or inferior material; poor workmanship; abuse of material, as when unmatched rivet holes are drift-pinned to place, or uncylindrical shells are sledged to form; of employing the more dangerous lap joint for the side seams instead of the more safe and more sensible butt joint, etc.

The lap joint is dangerous because this form of construction promotes the formation of incipient cracks in the upper surface of the lower lap where they may be impossible of detection. These cracks extend from rivet hole to rivet hole and gradually deepen with the continued raising and lowering of the steam pressure until the metal, no longer capable of resistance, gives way and causes a violent explosion.

The lap joint is given the preference over the butt joint solely, because, it appears at first thought to be cheaper. But there is no excuse for its existence, and its employment in the construction of new boilers should be prohibited by law in all states, as it now is in some.

Improper installation may consist of so supporting the boiler and its piping as to allow temperature changes to set up dangerous stresses in the material, of improperly attaching the usual appurtenances such as safety valves, steam and water gauges, check, blowoff, stop valves, etc.

Incompetent or careless operation may consist in allowing the steam gauge to get out of order, in allowing the water-gauge connections to become so clogged as to indicate ample water when there is none in the boiler, in allowing the safety valve to become so stuck to its seat as to fail to blow at the pressure for which it was set, in allowing grease to enter or scale to accumulate in the boiler, in allowing large quantities of cold water to be impinged against hot plates, in allowing the water to be driven from the heated surfaces by forced firing, in allowing a large valve to be opened too suddenly, in allowing two boilers to be cut in on the same steam main when their pressures are unequal, and in allowing minor repairs to be neglected until they endanger the whole structure.

It is significant that many violent boiler explosions occur either just prior to the starting of the engines in the morning or while they are idle at the noon hour, or shortly after they have been shut down for the day. One reason is that when steam is not being drawn from the boiler it accumulates rapidly; and if the safety valve fails to relieve the pressure, explosion soon follows.

The rapidity with which the bursting pressure is reached may be shown as follows:

Let

T = Time in minutes required to reach the bursting pressure;

W = Weight of water in the boiler;

t = Temperature of the steam at bursting pressure;

t' = Temperature of the steam at normal working pressure;

U = Number of heat units per minute supplied by the furnace and absorbed by the water.

The heat balance is then represented by the equation:

$$UT = W\,(t - t')$$

$$T = \frac{W}{U}\,(t - t')$$

which means that if we multiply the difference between the temperature of the steam at bursting pressure and at normal pressure by the weight of the water in the boiler, and then divide the product by the number of heat units supplied per minute by the furnace, the result will be the number of minutes that will elapse from the time the openings are all closed until explosion follows.

Take, for example, a 100-h.p. boiler containing at normal level 5,000 lb. of water and suppose it uses 50,000 heat units per minute when evaporating 50 lb. of water per minute. Then if the normal gauge pressure be 85 lb., the corresponding temperature of the steam is 327 deg., and if the bursting gauge pressure be 485 lb., the corresponding temperature of the steam is 467 deg.; and the time required to reach the bursting pressure with all steam openings closed and the safety valve stuck is:

$$T = \frac{5{,}000}{50{,}000}\,(467 - 327) = 14 \text{ min.}$$

That is, with a stuck safety valve, only 14 minutes would elapse from the time the engines were shut down until the explosion followed.

The temperature of the water in a boiler is approximately the same as the temperature of the steam with which it is in contact. If the fire be drawn when the openings are closed, ebullition ceases. If a valve be opened, ebullition starts again, even though there still be no fire under the boiler.

It is plain, therefore, that with the openings closed it is the pressure on the surface of the water that prevents further generation of steam. It is also plain that if a small rupture below the water line a violent explosion may not ensue. But it ought to be evident that if a large outlet above the water line be suddenly opened, as, for example, when a steam pipe fails, then the sudden liberation of the pressure on the surface of the high-temperature water will allow it to flash suddenly into steam and cause a violent explosion and water-hammer that will disrupt the strongest possible construction.

Grease does not dissolve or decompose in water, nor does it remain on the surface. Heat in the water and its violent ebullition causes the grease to form in sticky drops which adhere to and varnish the metal surfaces of the boiler. This varnish by preventing the water from coming into intimate contact with the metal, prevents the water from absorbing the heat, and this causes a blistering or burning of the plate that often results in a serious rupture, or a violent explosion.

If scale is allowed to accumulate to any considerable thickness in a boiler, a bag or rupture of the shell is inevitable, unless the scale happens to be of a spongy formation, which is not often the case. Just why this is so, is shown by the following simple experiment.

Take an ordinary granite iron or tinned iron stewpan and firmly glue to its underside a postage stamp. Pour water into the pan and place it on a gas stove so that the postage stamp will be in direct contact with the flame. Leave the pan on the stove until the water has boiled violently and then examine the stamp. The stamp will not even be charred, much less burned, notwithstanding that it was on the underside of the pan and in direct contact with the hottest part of the flame.

Now put into the pan a mixture of water and Portland cement half an inch thick. This, when set, will be the equivalent of half an inch of scale. Repeat the experiment made before and it will be found that the stamp will burn up very quickly.

The reason that the postage stamp is not charred by the flame when no scale is present is that the water, being in immediate contact with the thin bottom of the vessel, absorbs the heat as fast as it is put into the vessel by the flame. The result is that, no matter how hot the flame may be, the bottom of the vessel remains at practically the same tem-

perature as the boiling water with which it is in contact. In an open vessel the temperature of boiling water is 212 deg. and this is not sufficiently high to char paper. When scale is present, the water cannot absorb the heat as fast as it is put into the vessel by the flame, and as a result the temperature becomes greater than 212 deg. and burns the postage stamp.

It is the same with steam boilers. If the water comes in direct contact with the thin plates, the heat is absorbed, the temperature of the plates remains practically the same as the water, and no harm is done. If there be a considerable thickness of impervious scale in the boiler, the water cannot absorb the heat as fast as it is put into the plates by the furnace, and so the plates become overheated, get red, become plastic, and finally give way to the force of steam pressure, causing a bag, or a rupture, or a violent explosion of the boiler.

Scale endangers the safety of boilers in other ways. It clogs the feed pipes, preventing the feed water from freely entering the boiler. It clogs the connections to the water gauge, causing it to indicate ample water when it is at a low level in the boiler. Pieces get under valves and prevent their closure.

Scale in boilers is a serious matter, and in order to prevent its accumulation, it is good practice to eliminate the scale-forming matter from the feed water before allowing it to enter the boiler. This can be accomplished either mechanically by means of separators, or chemically by treating the water in vats especially arranged for the purpose. If preferred, compound may be fed with the water into the boiler, but in such case the water should be analyzed, and the proper compound prescribed by a chemist making a specialty of such matters. Kerosene fed into the boiler has proved beneficial in many instances.

It is an almost universal custom for boiler owners to have their boilers insured and inspected. The insurance serves as a guarantee that the inspections will be intelligently and carefully made and the inspections lessen the chance of accident.

When boiler insurance is carried, an inspector visits the plant at regular intervals and critically examines the boilers, both internally and externally. During the past 10 years the company represented by Mr. Boehm made 1,101,140 examinations and reported 140,989 defects, many of which consisted of dangerous fractures in or near the riveted seams, and that one boiler out of every eight examined, contained defects serious enough to warrant their being reported.

CLEANING THE WATER MAINS.

It is of interest to note that during the past five years the water department of Cincinnati had been been almost constantly employed in removing deposits from the water mains of that city. Previous to 1907 the muddy Ohio River water, having a turbidity varying from 7 parts per million to over 300 parts per million, was pumped directly into the distribution system. In 1907 the purification plant was installed and placed in operation. The deposits in the mains so decreased their capacity as to make it necessary to remove them, and although the work has been in progress for five years a large part of the system still remains to be cleaned. The enormity of the expense of cleaning will be recognized from the cost figures which vary from 10 cents to 26 cents per foot of pipe cleaned. The carrying capacity of the distribution system is greatly increased after the deposits are removed and an increased pressure results at all points on the distribution system.

DRIVING THE LARAMIE-POUDRE TUNNEL.

General methods and records of progress in driving the Laramie-Poudre Tunnel were described in our issue of April 10, 1912. The bonus system used in paying the men and descriptions of the method of loading the holes is of special interest and are further described in a paper by David W. Brunton, published in a recent Bulletin of the American Institute of Mining Engineers. We abstract from this paper as follows:

European tunneling methods were copied as closely as the American wage scale and differences of conditions would permit. A workman once assigned to a position in the tunnel remained there, not being allowed to change even from one side to the other. He was not allowed to drop his tools at shift-change, but was obliged to hand them to his successor, and, in case of his successor's non-arrival, was expected to work another shift, care being taken, of course, that either a substitute was found, or meals were sent in to the man working a double turn.

To give each man a personal interest in the work a bonus system was maintained. At first the bonus paid to each underground workman was 25 cents per day for each 25 ft. in excess of 400 ft. for the month.

After a few months this schedule was discontinued, as it was found to be both cumbersome and excessively high, considering the rate of progress made possible by the superior equipment; and the following bonus rate was adopted:

When the rate of driving for any calendar month exceeded 400 ft. and was less than 500 ft., each underground employee was paid $10 extra; between 500 and 600 ft., the bonus was $15; and between 600 and 700 ft., $20.

This bonus should have been paid to the men in currency, so as to distinguish it from the earnings under the wage schedule, but, as this was impracticable, money earned under the bonus was paid with a separate check, thus giving the men a better opportunity to realize what speed meant to them as well as to the contractor.

The list of employees and their rate of wages is as follows:

1 Superintendent		$ 10.00	per day
3 Foremen	each	5.00	per day
9 Drillers	each	4.50	per day
6 Helpers	each	4.00	per day
18 Muckers	each	3.50	per day
6 Drivers	each	4.50	per day
3 Dumpers	each	3.50	per day
1 Track and pipeman		3.50	per day
1 Master mechanic		6.00	per day
1 Stable boss and janitor		3.00	per day
2 Power engineers	each	110.00	per mo.
1 Car greaser		3.00	per day
1 Man at odd jobs		3.00	per day
1 Timberman		4.00	per day
1 Timberman's helper		3.50	per day
2 Blacksmiths	each	5.00	per day
2 Blacksmith's helpers	each	3.50	per day
1 Book and timekeeper		110.00	per mo.

In the operations of setting up the machines, drilling, firing and mucking, the utmost regularity and system were observed; and, while the time consumed in these different operations varied somewhat from day to day, there was a remarkable degree of uniformity in the amount of work performed by the different shifts.

Picking down the roof and squaring up places on the sides for the drill-bar rarely occupied more than 10 minutes. The adjustable end of the cross-bar was always placed on

the right-hand side of the tunnel, the lifter on this corner having been exploded last for the purpose of clearing away the muck and leaving plenty of room for the men to operate jack-bars. The drillers and the foreman attended to this work while the helpers were busy bringing forward the hose, air-pipe, water-pipe and steel. Even with the tremendously heavy charges fired, most of the broken rock lay within 30 ft. of the face and rarely exceeded 5 ft. in depth at any point, making it easy to bring the bar and drills over the muck pile.

The fuses were always ignited and the charges fired in rotation.

The usual practice of tamping the holes over the explosive was soon discontinued, as it was found that with such heavy charges the powder formed its own tamping, with the further advantage that when the holes were loaded to the collar the rock was more thoroughly pulverized and consequently much easier shoveled into the cars than when lighter charges were used.

Holes will occasionally miss fire, even when loaded with the greatest care; and when no tamping is employed they can be afterwards fired by simply pushing a primer down tightly upon the unexploded charge, without taking the risk of performing that most dangerous of all operations, picking the tamping out of a "missed" hole.

At first, each pair of fuses was lighted about ten seconds before the next—which, on 40-second fuse, gave 3-in. steps on the receding line of fire. This interval, however, being repeated on 10 pairs of holes, occupied considerable time, and the smoke became so intolerable that some method of expediting the rate of fuse-lighting had to be adopted. The one which proved most satisfactory was exceedingly simple. The foreman cut 22 ins. from the ends of the fuse protruding from the short cut holes; 20 ins. off the fuse from the upper cut holes; 18 ins. off the fuse in the lower cut holes, and so on. This automatically provided a difference of 2 ins. in the distance the fire had to travel, and, even when the fuse-ends were lighted as rapidly as possible, at least another inch was represented by the time between the lightings, so that the two shot-firers could secure the necessary interval between the explosions, and yet get away from the face before the smoke from the burning fuse became too dense.

The following tabular recapitulation of the drilling-operations shows that the men could not only complete a round in an 8-hour shift, but had sufficient extra time to provide for shooting missed holes or taking care of any of the minor difficulties which often arise in tunnel work.

Time Occupied in Various Operations.

Exhausting smoke from face	10 to 12 min.
Picking down roof and sides	5 to 10 min.
Jacking cross bar in place	6 to 8 min.
Attaching drills, making hose and water connections	5 to 15 min.
Drilling from top set-up	3 hr. to 4 hr. 15 min.
Dropping horizontal bar to lower position	15 to 20 min.
Drilling on lower set-up	1 hr. to 1 hr. 15 min.
Removing drills, cross bar, hose, etc.	15 to 20 min.
Blowing out holes, loading and firing	20 to 25 min.
Ignition to explosion of last hole	8 to 8 min.
Total time required to complete cycle of operations	5 hr. 24 min. to 7 hr. 28 min.

During March, April and May, 1911, the record months for driving, the following data were gathered, showing the amounts of work done:

	March.	April.	May.
Ft. of tunnel driven	653	583	635
Number of holes drilled	1,965	1,759	1,985
Linear ft. of holes	14,330	12,510	15,263
Ave. lin. ft. of holes daily	154	139	164
Sticks of powder used	14,808	16,171	18,311
Cars (16 cu. ft.) of muck sent out	4,983	4,765	5,156

Considering the hardness of the rock, the speed attained in drilling, as shown by the figures above, was exceptionally good; but even these averages fall considerably below what was possible with the equipment used. For instance, a number of the best drill-runners were able to average over 60 ft. of holes per shift, one of them making a monthly shift average of 61.68 ft.; another of 61.75 ft.; and a third of 61.86 ft.

While this work shows a great advance over current American practice, it still falls behind the records obtained in the best examples of European tunnel driving. A direct comparison, however, is not quite fair to the United States, since the Alpine tunnels are very much longer than anything yet attempted in this country. At first sight, it would seem that additional length would tend to retard instead of accelerate the rate of progress; but this is not the case. It has been clearly shown that the increased length of transportation and difficulty of ventilation are much more than offset by the improved conditions and the perfection of organization effected by time and experience. As a rule, the greater the magnitude of the undertaking the more thorough the preparation; and the time and labor expended in studying conditions and designing plants for the different Alpine tunnels have been more than justified by the results obtained. European tunnel engineers have also the advantage of being able to select their employees from an almost unlimited supply of highly-skilled workmen from the Tyrol, Switzerland and Piedmont, which gives them an incomparably better selection than can be drawn from our heterogeneous labor supply.

ILLINOIS WATER SUPPLY ASSOCIATION.

The fifth annual meeting of the association will be held at the University of Illinois, Champaign-Urbana, Illinois, March 11 and 12, 1913.

Titles of papers to be presented at the meeting should be sent to the secretary before February 20, 1913. A number of good papers have been promised, but we have room on the programme for more. Prepare a short paper, 1,000 to 1,500 words, on some topic that has been interesting you and that may help someone else. Send to the secretary items that are troubling you. The programme committee can arrange to have a discussion on the subject.

Associates intending to exhibit, please notify Mr. G. C. Habermeyer, Engineering Hall, University of Illinois. The usual arrangements have been made for the exhibits. If the exhibits are sent in care of Mr. Habermeyer they will be delivered at the University.

In the hydraulic laboratory there will be an exhibit of apparatus illustrating the principles of washing filters. In the water survey laboratory there will be an exhibit of water softening by permutit and water sterilization by ultraviolet light.

The University band will give an informal concert for the association. A subscription dinner will be held Tuesday evening, March 11. In order that suitable arrangements may be made, sign and return the enclosed card to the secretary at once. Programmes showing railway lines and hotel accommodations will be mailed February 24 to members and to others who return the card. Edward Bartow, secretary.

COAST TO COAST.

Steveston, B.C.—The cost of engineering ventures, road and sidewalk extension, during 1912 was $70,000, and is divided up into the wards as follows: Ward I., $7,595.23; Ward II., $7,605; Ward III., $10,705; Ward IV., $11,062.50; Ward V., $23,193.65.

Fort William, Ont.—The first two car loads of structural steel to be used in the construction of the plant of the Canada Car and Foundry Company, arrived in this city recently, consigned to the Dominion Bridge Company. There will be 3,000 tons of metal in the buildings of the Car Company's plant here.

Prince Albert, Sask.—The new council of this city decided to erect a market building, appoint a parks board to take charge of the Prince Albert annual exhibition, to push forward as quickly as possible the erection of an isolation hospital, and to take immediate steps towards the erection of an incinerator.

Regina, Sask.—A material reduction in the cost of power to the citizens of Regina has been recommended owing to the large surplus of $70,000 having been obtained by the power plant last year. It is the intention of the officials to charge a rate that will only be sufficient to pay the cost of producing power and provide a slight surplus each year.

Halifax, N.S.—The plans providing terminal facilities that will make Halifax the best equipped port on the continent, while it will enjoy the advantage of being the nearest of all the ports to Europe, were discussed by Senator Wm. Dennis, who is on his way to Ottawa. It is understood that the development and equipment that is to provide for Halifax's present needs and its wants in the immediate future will involve an expenditure of at least $20,000,000.

Moose Jaw, Sask.—Evincing the progressive tendencies of Western Canadian municipalities, Leonard W. Rundlett, former St. Paul city engineer, now city commissioner of Moose Jaw, cites the fact that this city is installing a high pressure system of fire protection. The method is used in but few cities of the United States. Winnipeg, Toronto and Moose Jaw are the only Canadian cities with high pressure systems. As a starter for the work $600,000 has been appropriated.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.

The annual meeting of the American Institute of Consulting Engineers was held January 14, 1913, at the Engineers' Club, New York City.

Mr. Henry Holgate, of Montreal, Canada; Mr. Daniel E. Moran, of New York City, and Mr. Charles Sooysmith, of New York City, were elected members of council to serve three years, and Mr. F. A. Molitor, of New York City, was elected a member of council to serve one year.

After the routine business of the meeting was transacted, Prof. George F. Swain, of Harvard, addressed the meeting on the question of "Education," which was very ably discussed by Mr. Rudolph Hering, General T. A. Bingham, Prof. Gardner S. Williams, of Ann Arbor, Michigan, and Mr. Frank J. Sprague. Mr. Eugene W. Stern is the secretary.

Mr. Noulan Cauchon, A.M.Can.Soc.C.E., addressed the members of the Ottawa Branch of the Canadian Society of Civil Engineers and their friends on Thursday, December 16th. He chose as his subject "Town Planning and Beautification," illustrating his various statements with lantern projections depicting work of this nature in Europe.

TORONTO UNIVERSITY ENGINEERING SOCIETY MEETING.

On Tuesday, January 21st, Mr. Frederick W. Taylor addressed the Engineering Society of the Faculty of Applied Science and Engineering of the University of Toronto on "Scientific Management." The meeting was held in Convocation Hall, about 700 being present.

"Any scheme that makes for increased efficiency cannot be stopped. History shows this time and again," was the keynote of Mr. Taylor's address. Mr. Taylor illustrated this by referring to the many futile strikes that have taken place on the introduction of means to increase efficiency. The attitude of the workman in "soldiering" was a result of a mistaken attitude of financial men in not paying sufficiently for increased output. "The workman is no fool. He soon learns how little he can do for the money," he said. It was the overcoming of this attitude in employer and employee that was the main problem in introducing scientific management.

PERSONAL.

J. McD. PATTON, superintendent of waterworks, of Regina, Sask., has tendered his resignation to the city commissioners.

CLIFFORD RICHARDSON, M.Am.Soc.C.E., consulting engineer, New York City, on January 17th delivered a lecture on "The Economics of Highway Construction," before the graduate students in Highway Engineering at Columbia University.

C. L. FELLOWES has resigned his position of deputy city engineer of Toronto, which he has held since 1898. Mr. Fellowes, in all probability, will remain with the Works Department and will take charge of the plans for the new mains and services in the Waterworks Department.

F. A. CREIGHTON, of Prince Albert, Sask., who recently resigned his position in that place as city engineer, has been offered the position of manager of construction of La Colle Falls civic electric development project. He will also be retained as consulting engineer in any engineering problem that may arise.

GEORGE POWELL, B.A.Sc., has succeeded Mr. C. L. Fellowes as deputy engineer of the city of Toronto. The former post held by Mr. Powell of principal assistant engineer is abolished. Mr. Powell is a graduate of the School of Practical Science in Civil Engineering. During 1903-4 he was employed with the Canadian Niagara Power Company at Niagara Falls, Ont., on the work incidental to the installation of their new plant. In the fall of 1904 he came to Toronto to act as engineer for a firm of contractors. Mr. Powell entered the service of the city in 1906, and has been with them continuously to date.

ANTHONY D. MacTIER, who was appointed as general manager of the Eastern lines of the Canadian Pacific, with headquarters at Montreal, Que., recently, was born on December 27, 1867, at Blairgowrie House, Scotland, and was educated at Sedbergh school, Yorkshire, England. He began railway work in May, 1887, in the general baggage agent's office of the Canadian Pacific, and was later in the general superintendent's department. He was then in the department of the superintendent of sleeping, dining and parlor car stores, and later in the car service department. In April, 1896, he was appointed general baggage agent, and in November, 1890, became general fuel agent. He was appointed assistant to the vice-president of the Canadian Pacific in June, 1907, and now becomes general manager of the Eastern lines of the same road.

ANNUAL MEETING OF ONTARIO GOOD ROADS ASSOCIATION.

The annual meeting of the Ontario Good Roads Association has been announced for February 26th, 27th and 28th, and the programme now in course of preparation will be issued shortly. Road construction and maintenance, concrete and steel bridges, and the building of town streets, will be discussed. Honorable J. O. Reaume, Minister of Public Works, will deliver an address. L. W. Page, Director of the United States Office of Public Roads at Washington, will attend and address the convention on "Road Maintenance." The city engineer of Toronto, Mr. G. G. Powell, will contribute a paper on "Town and City Streets." Other addresses will be delivered by the mayor of Toronto, the president of the Toronto Board of Trade, and Mr. W. A. McLean, chief engineer of highways for Ontario, who will discuss county road organization and construction.

COMING MEETINGS.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

ENGINEERS' CLUB OF TORONTO.—Meeting of the Members will be held on Friday evening, January 24th, at 8 p.m., in the Lecture Room, 96 King Street West, Toronto. Secretary, R. B. Wolsey.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre: Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr, G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—P e ident, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Jan. 30, 1913 Contents of this issue on page 245

The Canadian Engineer

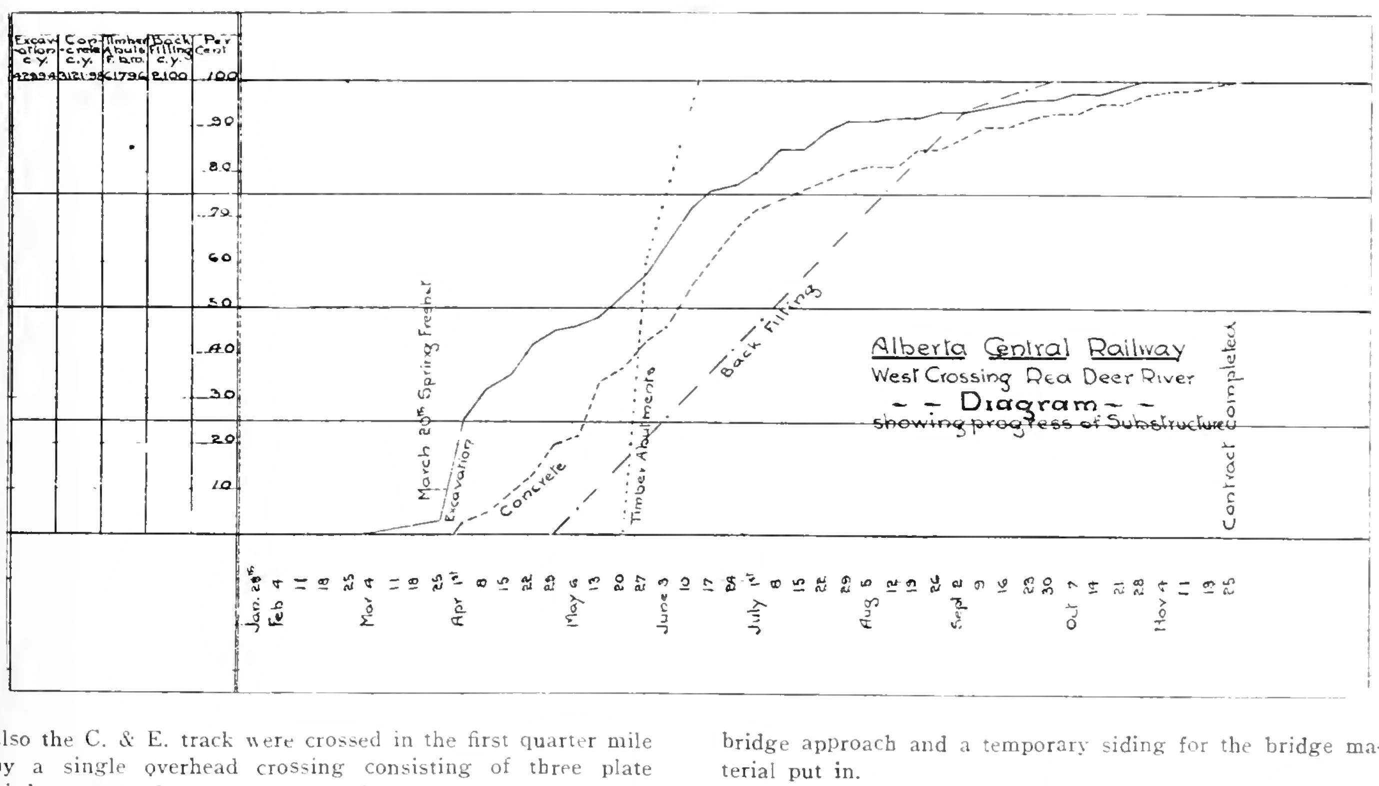
An Engineering Weekly

THE RED DEER RIVER BRIDGE—ALBERTA CENTRAL RAILWAY

By HUGH A. LUMSDEN, B.Sc.

The Alberta Central Railway obtained its charter from the Dominion Government in 1909. The line was projected both east and west from Red Deer, a growing town of about 2,500 population, midway between Calgary and Edmonton on the C. & E. branch of the Canadian Pacific Railway. Mr. J. Grant MacGregor was appointed chief engineer and location surveys were made during the winter of 1909-10.

Construction was commenced by the company in the summer of 1910, the first spike being driven by Sir Wilfrid Laurier in August of that year. The Waskasoo Creek and



also the C. & E. track were crossed in the first quarter mile by a single overhead crossing consisting of three plate girder spans, the centre one resting on concrete pedestals 25 feet above the C. & E. track, and the ends resting on wooden abutments. No other engineering difficulties were met with until mile 5.5, where the banks of the Red Deer River were encountered, and it is with the crossing of this valley that this article is chiefly concerned.

Many preliminary surveys for the bridge were made, and after months of careful study of the ground, the present and best possible location for the bridge was decided upon.

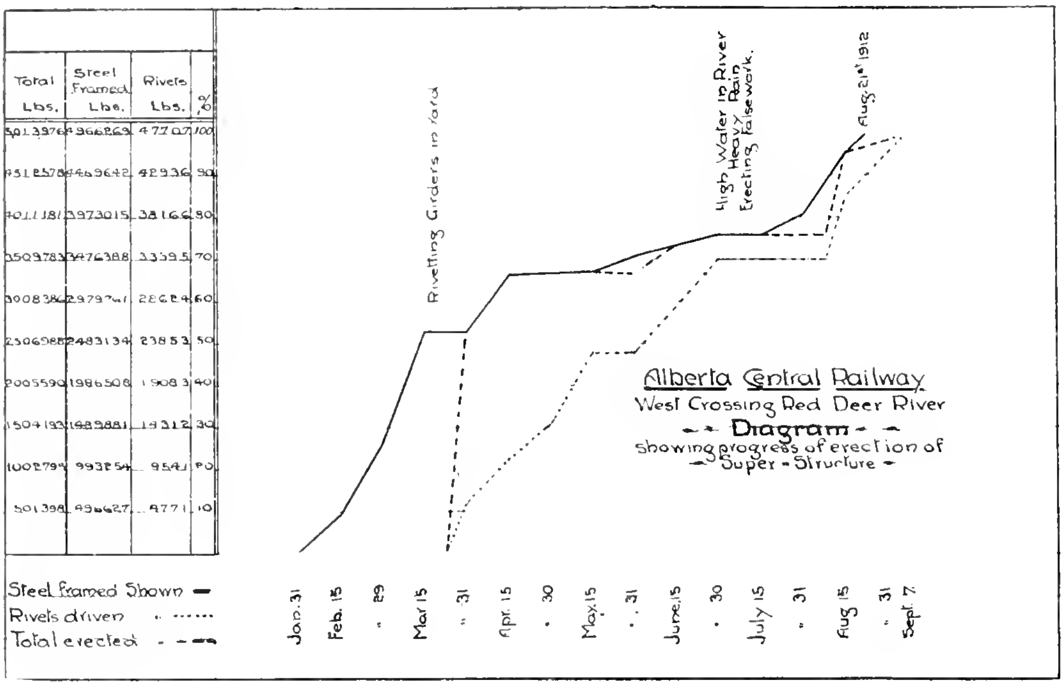
The Red Deer River itself is only about 300 feet wide, and averages about 5 feet deep with a mean discharge of about 2,200 cubic feet per second, but both the height and discharge vary very greatly with the season of the year. The valley through which it flows, is fairly wide, and in very few places only are the banks less than half a mile apart. The ground is a clayey loam with a layer of rock underlying the river bed. The east bank slopes gradually and reaches the flat 90 feet below in about 1,200 feet, falling slightly thereafter to the river's edge; the west bank is steeper, rising from the river bed 135 feet in a distance of 1,000 feet.

In the fall of 1911 track was laid from Red Deer to the bridge approach and a temporary siding for the bridge material put in.

The bridge is approached from the east on a 2 degree curve ending about 700 feet back of the abutment. The alignment is a tangent throughout and the gradient a 0.4 per cent. rising westward. The total length of the bridge is 2,172 feet 6 inches from end to end of the abutments. Three hundred feet west of the bridge a long 5 degree curve commences and the line swings northwards.

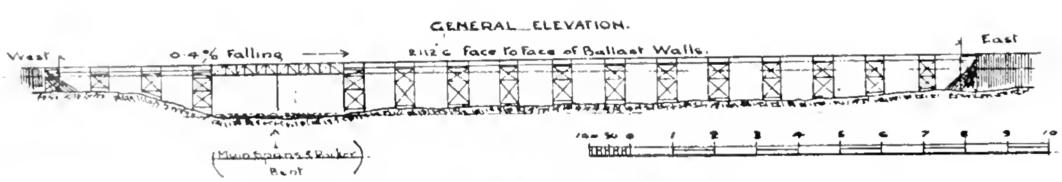
The wooden abutments at either end of the bridge were built by the Alberta Central, the pile driving being commenced about the end of March, 1911, and the abutments completed early in June.

The embankment at the end of the east abutment is about fifty-five feet high and that at the west about forty feet; the approaches were graded by sub-contractors under D. F. McArthur and Company. Some trouble was later experienced, due the sinking and shoving forward of these abutments caused by the shrinking and pressure of the embankments, but it is the intention in due time to replace the present structures by those of concrete.



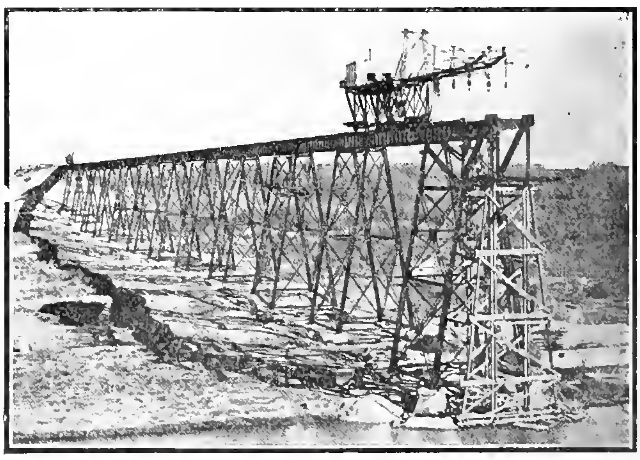
The original design for this bridge was prepared by the chief engineer in 1909 and submitted in 1910 to Mr. P. B. Motley, consulting bridge engineer for the Alberta Central and Canadian Pacific Railways, who made certain changes and modifications and introduced a rocker bent. The design thus decided upon, with the exception of the main truss spans, the rocker bent and the deck floor, was very similar to that of the Lethbridge viaduct, built by the Canadian Pacific Railway in 1907-08. It consists of fifteen deck plate girder spans each 74 feet 10 inches long and fifteen similar girder spans each 45 feet long, carried on 30 rigidly braced steel towers, the distance centre to centre being 45 feet, and of adjacent towers 75 feet. The river itself was spanned by two rivetted deck truss spans of the Warren type, each 150 feet long, supported by towers at one end of each and at the centre by a single pair of legs about 80 feet long forming a rocker bent. This rocker bent is perhaps the most unusual feature of the whole bridge, and is a form of construction which has not been very widely used in bridge building in Canada hitherto; in such a case as this, however, replacing, as it does, a very high and expensive concrete pier it makes a very serviceable and neat member.

The contract for the substructure of the bridge, consisting of 56 pedestals, 4 piers, two on either side of the river and a large centre pier in the middle of the river, and containing in all about 3,122 cubic yards of concrete, was awarded Messrs. Jackson and Goldie, of Winnipeg. Excavation was commenced by them on March 1st, 1911, and the last pier completed on November 21st.



General Elevation of Bridge.

The contract for the superstructure was awarded the Canadian Bridge Company, of Walkerville, Ont., who commenced erection on the last day of January, 1912, having previously erected their traveller and assembled much of their material on a siding just east of the bridge site. Erection proceeded very rapidly and towards the end of April tower 24 (numbered from east to west) was reached, and the erection of falsework for the first main span across the river commenced. Here the first and only accident occurred, a man being instantly killed by falling about 40 feet while erecting falsework. Considerable delay was now experienced, due the excessively heavy rain which fell the greater part of July and not only prevented work, but raised the river to such an extent that even the erection of falsework had to be discontinued for nearly three weeks. A few bents which were being used as a temporary platform were carried down the river and recovered near Red Deer. In the meantime rivetting up of back work was proceeded with by "four guns," steam being obtained from an engine in a shed close to the river bank, where also the bridge camp was situated. The falsework, consisting of six bents resting on piling, is well illustrated in one of the accompanying photographs.



Progress of Erection, Middle of May, 1912, Looking East.

The rocker bent and second main span were completed by the middle of August, and on August 21st, 1912, the last girder was lowered into place, and after two weeks more spent in rivetting and paint-

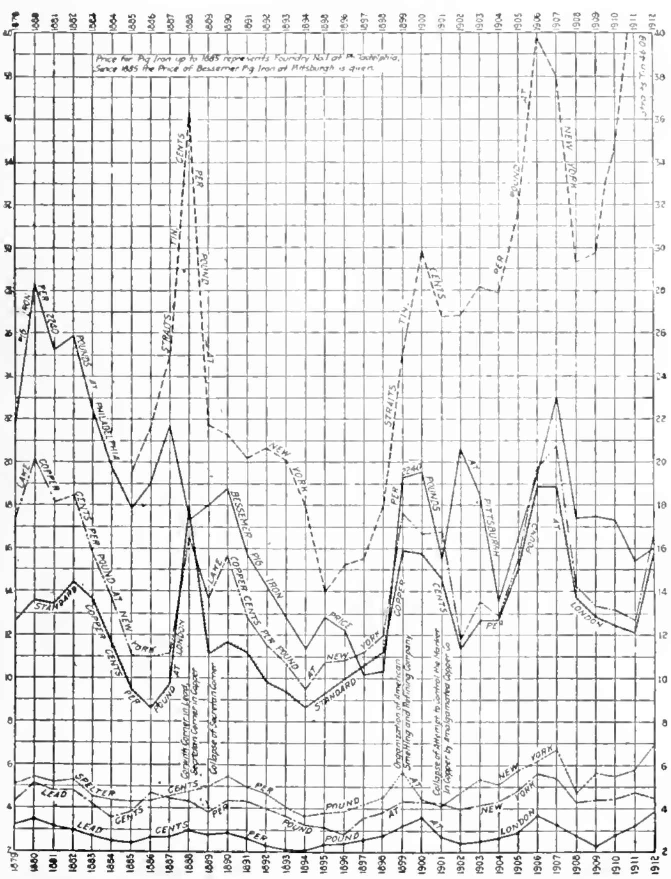
ing the bridge was completed. The total weight of steel placed in the bridge was 3,013,976 pounds.

The work was under the direct supervision of Mr. MacGregor, assisted by a resident engineer at the bridge. Mr. R. Turner was C.P.R. bridge inspector on the work and Mr. T. Frankish superintendent of construction for the Canadian Bridge Company.

View Showing Lateral Bracing of Main Truss Spans.

View of the Completed Pier No. 26.

Accompanying are several photographs of the work taken during erection; also diagrams showing the progress of erection both of the substructure and superstructure.



Course of Metal Prices Since 1879—Annual Averages as Compiled by the Engineering and Mining Journal.

CANADIAN RAILWAYS AND ROLLING STOCK IN 1912.

The year 1912 was a period of great activity in railroad car construction as well as rail extension and a resumè of the car and locomotive orders issued by the directorate of the various Canadian roads during the past twelve months makes an interesting item.

The following are the orders of the Canadian Pacific Railway:—

Box cars	24,141
Flat cars	1,370
Stone cars	400
Ballast cars	616
Stock cars	865
Refrigerator cars	522
Horse cars	38
Dump cars	20
Tank cars	20
Automobile cars	100
General service cars	411
	28,403

The passenger car orders are composed of:—

Sleeping cars	106
Dining cars	25
Tourist cars	57
Baggage and express cars	76
First-class cars	117
Compartment sleeping cars	3
Buffet parlor cars	8
Colonist cars	2
Second-class cars	12
Mail and express cars	13
Baggage and smoker	1
Horse express cars	2
Fruit express cars	1
Baggage cars	50
	473

The locomotive orders of this company for the period mentioned consist of 493 machines of the superheater type in sizes ranging from 19 x 24 to 23½ x 32 inches.

The Canadian Northern have placed some large orders for rolling stock during the past year, their freight car orders being composed of the following:—

Box cars	3,600
Automobile cars	100
Flat cars	1,050
Caboose cars	50
Tank cars	10
Refrigerator cars	100
Stock cars	150
Construction cars	324
	5,384

Passenger cars ordered by this company indicate increased business, and comprise the following:—

First-class cars	30
Café-parlor	2
Baggage	15
Baggage and mail	9
Dining cars	2
Sleeping cars	16
Second-class	25
Self propelled	1
	100

The locomotive orders are for 104 superheater machines varying from 24 x 32 to 19 x 26. When the car orders of the Canadian Northern Railway are considered it is necessary to enumerate the orders of the Canadian Northern Ontario and the Canadian Northern Quebec Railways, both of which are connected with the Canadian Northern Railway. The freight car orders of the Canadian Northern consist of:—

Box cars	200
Coal cars	50
Construction cars	76
	326

Passenger car orders:—

First-class cars	12
Second-class cars	3
Café-parlor cars	2
Baggage cars	4
Dining cars	2
	23

Locomotives ordered number ten of the superheater type 22 x 26 inches. The freight car orders of the Canadian Northern Quebec Railroad are made up thus:—

Box cars	300
Flat cars	50
Coal cars	50
Caboose cars	20
	420

Passenger car orders:—

First-class	3
Second-class	12
Excursion cars	6
Café-parlor cars	2
Baggage cars	2
Baggage and mail cars	2
Self-propelled	1
	28

The management of this railway also ordered 8 locomotives of the superheater type; 6 were 22 x 26 and 2 were 19 x 26.

The freight car orders of the Grand Trunk indicate that that railway is rapidly forging to the front and consist of:—

Box cars	2,000
Refrigerator cars	500
Automobile cars	500
Flat cars	300
Tank cars	50
	3,350

The passenger car orders of this line are made up as follows:—

Sleeping cars	15
Second-class	10
Colonist	15
Tourist	5
Dining	6
Café-parlor	6
First-class	10
	67

The locomotive orders of the Grand Trunk Railway are for 100 machines in sizes ranging from 20 x 26 to 27 x 30 inches; 85 of these machines are of the superheater type. In addition to the locomotive orders of the Grand Trunk Railway it appears that 40 machines were ordered for use on the lines of the Grand Trunk Pacific; these machines are 23 x 30 and 33 x 30 inches.

The Intercolonial Railway officials have placed some large orders for rolling stock during the past year; their freight car orders tabulating as follows:—

Box cars	1,643
Construction cars	200
Flat cars	200
Refrigerator cars	30
Tank cars	1
Stock cars	20
Caboose cars	10
	2,104

The passenger car orders of these lines include:—

Sleeping cars	4
Dining cars	2
First-class cars	7
Baggage cars	3
	16

The locomotive orders of the Intercolonial number 28 machines in sizes varying from 20 x 26 to 24 x 32. Twenty of these machines are of the superheater type.

The Prince Edward Island Railway must be considered as next in order to the Intercolonial; the freight car orders of this line being for 15 construction cars and 1 tank car. There is no record of passenger car or locomotive orders for this line during 1912.

A small line that has done considerable ordering is known as the Paris and Mount Pleasant Railway. This line have placed orders for 12 box cars, 3 first-class passenger cars, and 1 combination car, in addition to one locomotive of the superheater pattern 18 x 24 inches.

The freight car orders of the Toronto, Hamilton and Buffalo Railway are for:—

Freight cars	1,250
Flat cars	10
Construction cars	254
	1,514

There is no record of any passenger car orders for this line for the past year, but 4 locomotives were ordered of the superheater type; two being 23 x 28 and two 21 x 28 inches.

The Temiskiming and Northern Ontario Railway ordered four box cars.

The Quebec Central ordered 100 rack cars and 6 locomotives.

The Algoma Central and Hudson Bay Railroad ordered 70 general service cars, 4 first-class passenger cars and 5 locomotives of the superheater type, each 22 x 28 inches.

The Algoma Eastern orders tabulate as follows:—

Box cars	25
Flat cars	24
Construction cars	70
	119

Passenger cars:—

First-class cars	2
Second-class cars	1
Passenger and baggage	2
	5

Locomotives ordered by this line were two in number, both of the superheater type.

The Sydney and Louisburg Railway ordered 75 hopper cars and 2 locomotives.

Although the steam roads have placed heavy orders, they are not the only large purchasers of rolling stock, as the following orders for electric cars will show.

The Berlin Street Railway Company purchases 1 open car.

The Berlin and Waterloo Street Railway purchases 2 semi-convertible cars.

The British Columbia Electric Railway purchased:—

Closed cars	109
Freight cars	115
Semi-convertible	35
Snow sweepers	2
Electric locomotives	5
Dump cars	6
Baggage and express cars	4
	276

The management of the Calgary Street Railway have placed the following orders:—

Closed cars	30
Trailer, passenger	1
Snow sweeper	1
Sprinkler	1
Sight-seeing car	1
	34

The Edmonton Street Railway Company or the Edmonton Radial Railway, ordered:—

Semi-convertible cars	50
Work car	1
Dump car	1
	52

The Guelph Radial Railway Company ordered 2 snow sweepers.

The Halifax Electric Tramway Company ordered 4 closed cars and 1 snow sweeper.

The International Electric Railway Company (Niagara District) ordered:—

Closed cars	326
Snow sweepers	4
	330

The Lethbridge Municipal Tramway Company ordered 10 closed cars.

The London and Lake Shore Railway and Transportation Company ordered 4 closed cars and 1 baggage car.

The Montreal and Southern Counties Railway Company ordered 6 closed cars and 2 combination cars.

The Montreal Tramway Company ordered:—

Closed cars	75
Snow plow	1
Snow sweepers	2
Crane car	1
	79

The Oshawa Electric Railway Company ordered:—

Convertible cars	2
Express car	1
Snow sweeper	1
Electric locomotive	1
	5

The Ottawa Electric Railway Company ordered 10 closed cars.

The Quebec Railway, Light and Power Company ordered 2 snow sweepers.

The St. Thomas Street Railway Company ordered 2 closed cars.

The City of Toronto Municipal Lines ordered 8 closed cars and 2 snow sweepers.

The York Radial Railway Company ordered 4 semi-convertible cars.

The Saskatoon Municipal Street Railway ordered 12 closed cars.

The Regina Municipal Street Railway Company ordered 30 closed cars.

The Nipissing Central Railway ordered 2 closed cars.

The Sandwich, Windsor and Amherstburg Railway ordered 2 closed cars.

The total number of cars and locomotives ordered during the year 1912 is 44,303.

The increase of electric railway mileage in Canada during the same period is shown below:—

Berlin & Northern Railway Co.—Through Bridgeport	0.25
Calgary Municipal Railway	18.50
Edmonton Radial Railway	2.50
Guelph Radial Railway Co.	0.60
Halifax Electric Tramway Co., Limited	0.75
Lethbridge Municipal Tramway	11.00
Levis County Railway.—Between St. Romaud and Gorman's Bridge	1.50
London Street Railway Co.	1.00
Moncton Tramways Electric & Gas Co., Limited	2.25
Montreal & Southern Counties Railway Co.—Between St. Lamberts and Greenfield Park	3.00
Montreal Tramways Co.—Montreal	2.07
Nipissing Central Railway.—Between Cobalt, Haileybury and New Liskeard	5.70
Oshawa Railway Co.—Oshawa	2.00
Regina Municipal Railway	3.50
St. Thomas Street Railway	0.50
Sandwich, Windsor & Amherstburg Railway.—In Windsor and Sandwich West	1.25
Saskatoon Municipal Street Railway	22.00
	78.37

MONTREAL AND SHAWINIGAN POWER RIGHTS.

An announcement of much interest to shareholders of the Montreal Light, Heat and Power and the Shawinigan Water and Power Companies is likely to be made soon in connection with the rights which are likely to accrue to them through the offering of the new issues of the Cedar Rapids Manufacturing and Power Company. A special meeting of the directors of the two companies first mentioned has been held to canvass the situation and the final details of the issue have been decided. Circulars will shortly be sent to the shareholders of the two concerns advising them of the offering of $8,000,000 of new bonds of the Cedar Rapids Company and the terms upon which the offering will be made. The price may be 90 per cent. of par, a bonus of 25 per cent. of common stock to accompany the bonds. The shareholders of the two companies will likely have the privilege of subscribing in the ratio of 30 per cent. of their holdings of Power or Shawinigan.

It is about a year since the interests in control of the two concerns came to the conclusion that they required the Cedar Rapids power for their future operations and reached an understanding with Mr. D. Lorne McGibbon for the purchase of a controlling interest. The Montreal Light, Heat and Power Company is the distributing agent in Montreal for the power it develops in its own plants as well as that developed by Shawinigan. It will also distribute for Cedar Rapids.

A RETAIL COAL HANDLING PLANT ON THE PACIFIC COAST.

From time to time articles have appeared in the technical press dealing with the getting of coal. It is proposed here to discuss its handling after leaving the mine and before it reaches the consumer.

The coal here considered is mined at South Wellington, Vancouver Island. It is a semi-bituminous coal and very friable. An analysis of a sample of screenings from this coal follows:—

	%
Moisture	2.0
Volatile combustible matter	35.10
Fixed carbon	43.6
Ash	18.5
Sulphur	0.8
	100.0

The coal is mined by means of coal cutting machines whilst the use of powder is being discontinued.

After arrival at the surface the coal is screened and picked, the screenings going to an independent screening and washing plant. The lump coal only as thus screened is dealt with in this article. The lump coal is delivered into railway cars straight from the screens, whence it travels seven or eight miles to the coast, where it is discharged from a trestle through chutes on to a belt conveyer, which carries it direct to a scow, passing over a weighing machine on the way.

Owing to the range of the tide (which is about 12 ft.); at low tide the depth from end of conveyer to deck of scow is about 20 ft. These two drops break up the coal considerably as the trestle is set high enough to take the screenings through the washing plant. The scows are towed about 55 miles to Vancouver, the re-handling plant being located on False Creek, right in the heart of the city.

The requirements of the trade demand that lump coal be free from slack and delivered in 100 lb. sacks.

The method originally employed was to wheel by barrow from scow to pile in shed. It was then screened, sacked and weighed as required.

Now the scow is brought up and made fast at end of wharf as shown in plan, the adjustable slip is lowered on to side boards of scow and the peak of the coal (coal is heaped on the scow from 10 to 12 ft. deep) taken off. The slip is then lowered to deck of scow end boards removed, and the

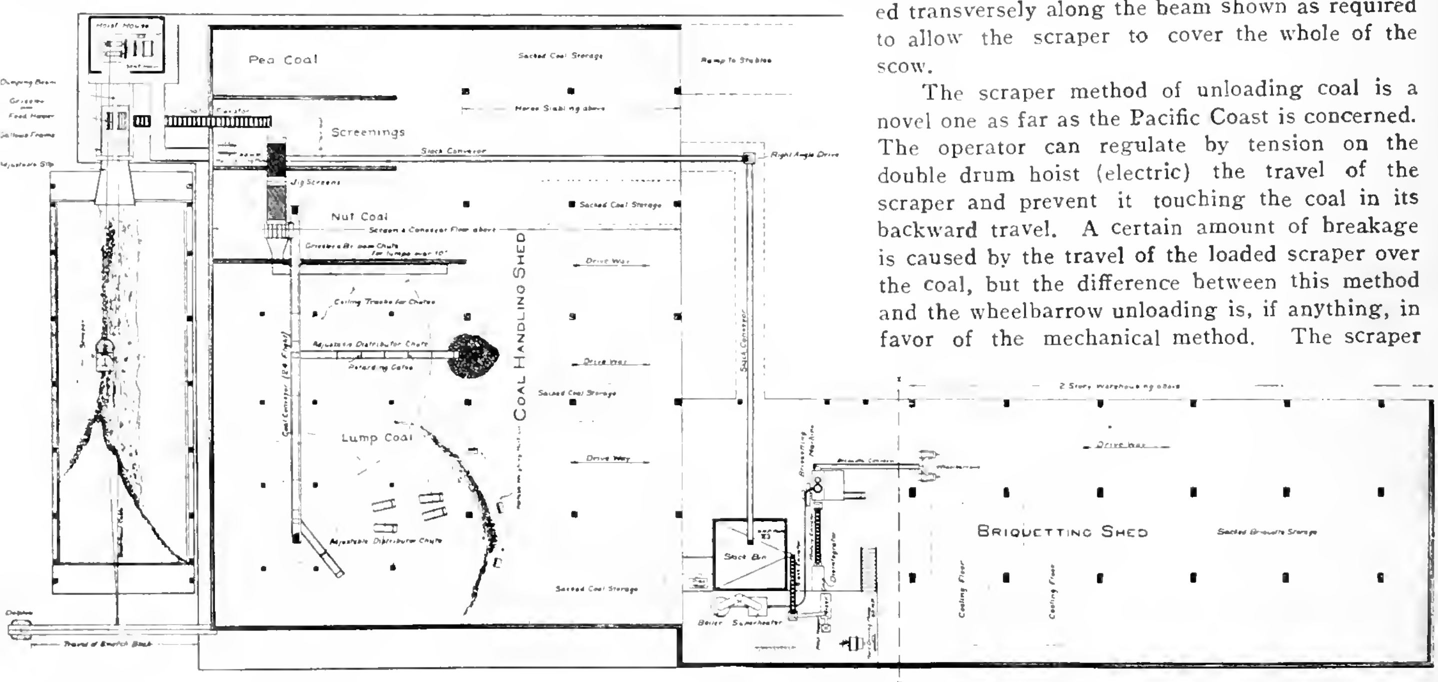
Slip for Unloading Coal on False Creek.

Vertical Heater Over Briquetting Plant.

remainder of the coal scraped off except a little in each corner near the slip. The scow is then turned end for end to permit of the remainder being removed. The operation can easily be followed from the plan, the snatch block being moved transversely along the beam shown as required to allow the scraper to cover the whole of the scow.

The scraper method of unloading coal is a novel one as far as the Pacific Coast is concerned. The operator can regulate by tension on the double drum hoist (electric) the travel of the scraper and prevent it touching the coal in its backward travel. A certain amount of breakage is caused by the travel of the loaded scraper over the coal, but the difference between this method and the wheelbarrow unloading is, if anything, in favor of the mechanical method. The scraper used is that patented by W. C. Weeks, and although designed for gravel handling, with minor alterations in the form of teeth, gives excellent resnlts with the coal. It is so arranged as to dump at the rear end by running the hauling cable over a snatch block located over the grizzly.

The unloading of coal by this method has proved very economical, whilst the first cost is considerably below the



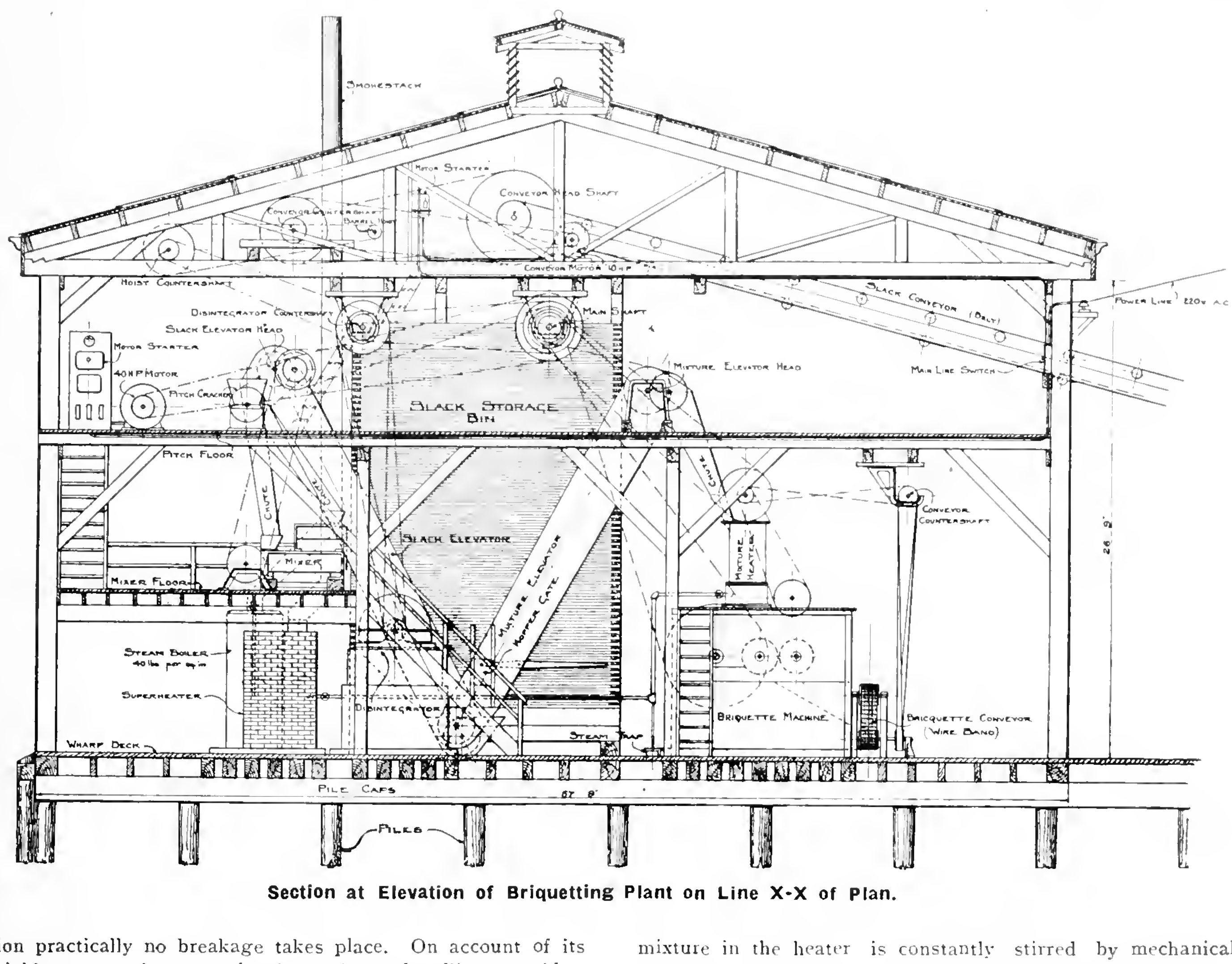
Diagrammatic Plan of Coal Handling Plant With Auxiliary Briquetting Plant on False Creek, Vancouver, B.C.

usual method adopted, viz., travelling derrick and clam shell bucket. A force of 12 men was formerly required to unload a 400 ton scow in 22½ hours. This is now accomplished by the scraper, with the assistance of two men, in 10 hours. From the receiving hopper the coal passes through a grizzly where everything over 18 ins. is retained until sledded down to that size. It is then conveyed by means of a bucket elevator to the jig screens which separate out the slack and nut into their respective chutes, whilst the lump passes forward on a flight conveyer to the adjustable distributor chutes. These chutes are hung from circular trackage from the ceiling so that they can be adjusted horizontally and and vertically. The coal is piled towards the front as shown in plan and as the pile increases the different sections of the chute are cast loose until such time as the coal piles back to the last section. These chutes are provided with retarding gates faced with rubber cushions to prevent breakage. When chutes are set at correct angle and retarding gates in operascreening, also now only half the number are employed sacking, the coal being taken direct from the pile on floor.

The slack chute discharges on to a 12-in. belt conveyer which takes it to a slack storage bin of 50 tons capacity in the briquetting shed. Here it is fed through a hopper as required to a bucket elevator.

The briquetting plant was manufactured by Yeadon and Sons, of Leeds, England, and is arranged as shown in plan and elevation.

The slack is conveyed by the bucket elevator to the mixer, whilst on the floor above the mixer is stored the pitch, and here is located the pitch cracker, so that the cracked pitch also falls into the mixer where it is fed on to the slack by an adjustable screw feed, regulated to give the correct percentage. From the mixer the product falls into the disintegrator. The mixture is then elevated into a vertical heater which is jacketed, and into which jacket steam, superheated to 360° F. at 40 lbs. pressure, is introduced. The



Section at Elevation of Briquetting Plant on Line X-X of Plan.

tion practically no breakage takes place. On account of its friable nature, however, in the entire re-handling considerable slack is formed subsequent to the first screening at the pit mouth, and this slack was formerly disposed of at greatly reduced value.

The percentage of slack on the scow runs (according to the stage of the tide at time scow is loaded) from 12 to 25% from tests made by careful hand screening, whilst after passing through the unloading and mechanical screening plant it is about the same, showing that the unloading and screening is not productive of furtner breakage.

The total number of men employed unloading and screening is three. Formerly the men sacking did the

mixture in the heater is constantly stirred by mechanical means so as to obtain a uniformly heated product and is then fed to the rolls of the press which turn out a briquette of an ovoid form weighing about 5½ ozs. each. These drop on to a wire band conveyer long enough to remove them clear of the plant, where they are received into wheelbarrows and spread over the cooling floors. Here they remain for 24 hours before being sacked. A small vertical boiler with separate bricked in superheater is used for supplying steam. The pitch used in the manufacture is coal tar pitch and amounts to 6% of the finished product for this particular coal. All the machinery is electrically driven by 220 volt three-phase induction motors.

A total of four men are required to run the briquetting plant. The briquettes find a ready sale at lump coal prices, whilst the demand is in excess of the output. They are giving every satisfaction both for furnace and range use.

The capacity of the plant is 45 tons per 10-hour run.

Head of Distributing Spout Showing Coal Feeding Into Same.

The coaling and briquetting plant here described is owned by the McDowell-Mowat Coal Co., Ltd., of Vancouver. Mr. Kerr, of the Canadian P. G. Mitchell Co., Montreal, superintended its construction. Mr. S. A. Lake, of Wilson and Lake, 422 Pacific Building, Vancouver, was the consulting engineer in charge of design and construction.

BRICKS FOR BUILDING AND FIREPROOFING

The total production of clay building brick, including the common and pressed varieties, and ornamental, paving firebrick, and fireproofing brick, is shown in the following statistics.

In 1911 the total sales were 732,901,056, valued at $6,515,472, made up of 645,550,517 common, valued at $5,420,890, or an average value per thousand of $8.37; and 87,350,539 pressed brick, valued at $1,094,582, or an average value per thousand of $12.53. In addition to the common and pressed brick there was a production of ornamental brick of 605,643, valued at $11,281, and a production of fireproofing brick and architectural terra-cotta valued at $409,585.

In 1910 the production was 627,715,319 common brick, valued at $5,105,354, or an average value per thousand of $8.13; and 67,895,034 pressed brick, valued at $807,294, or an average value per thousand of $11.89; the total of the two classes being 695,610,353, valued at $5,912,648. The production of ornamental brick in 1910 was 703,345, valued at $16,092; and of fireproofing and architectural terra-cotta, $176,979.

The increase in production of fireproofing has been particularly marked, and is due to the establishment of new plants, including the National Fire Proofing Company of Canada at Hamilton, Ont., and the Alberta Clay Products Company, Limited, of Medicine Hat, Alta.

The demand for brick has been very strong, particularly throughout the west, where numbers of plants are being increased in capacity and many new plants either contemplated or in course of construction.

The exports have never been large, averaging for a number of years past about $6,000 in value per annum, but falling in 1910 and 1911 to $2,762 and $3,977, respectively, according to the latest report of Mr. J. McLeish, B.A., chief of the division of mineral resources and statistics. The annual imports for a number of years previous to 1903 averaged only about $20,000 in value. During the past eight years, however, the imports have rapidly increased from $100,000 to nearly $500,000 per annum. During the calendar year 1911 the imports were 51,102,000 brick, valued at $475,865; of which 6,404,000, valued at $72,675, or an average of $11.35 per thousand, were imported from Great Britain; and 44,698,000, valued at $403,190, or an average of $9.02 per thousand, from the United States. The imports during the calendar year 1910 were 29,049,000 brick, valued at $274,482; of which 1,993,000, valued at $26,447, or an average of $13.27 per thousand, were imported from Great Britain; and 27,056,000, valued at $248,035, or an average of $9.45 per thousand, from the United States.

The total production of paving brick and paving blocks in Canada in 1911 was reported as 5,220,400, valued at $79,444, as compared with a production of 4,215,000, valued at $78,980 in 1910.

This paving brick is made at West Toronto, Ont., from shale obtained from the banks of the Humber River. The annual production has for a number of years varied from 3,000,000 to over 5,000,000 per season, and the output finds a market chiefly in Toronto. The average price per thousand has varied from $8 to $20.

The imports of paving brick have during the past three years exceeded the domestic production. During the calendar year 1911 the imports were 11,450 thousand, valued at $164,292, or $14.34 per thousand, and included 4,988 thousand, valued at $78,201, or $15.68 per thousand, from the United States, and 6,462 thousand, valued at $86,091, or $13.32 per thousand, from Great Britain. The imports during the calendar year 1910 were 10,503 thousand, valued at $124,994.

The manufacture of sand-lime or silica brick, although of comparatively recent origin in Canada, has developed with considerable rapidity during the past five years, for which statistics have been collected.

Returns received from sixteen producing firms showed total sales in 1911 of 51,535,243 brick, valued at $442,427, or an average of $8.58 per thousand, as compared with a production of 44,593,541 brick, valued at $371,857, or an average of $8.34 per thousand, by thirteen firms in 1910.

The total sales by nine firms in 1909 were 27,052,864 brick, valued at $201,650, or an average of $7.45 per thousand.

The number of men employed in 1911 was 337, and wages paid, $166,902.

RAILWAYS IN SASKATCHEWAN.

At the end of the season the Canadian Pacific Railway had 414.80 miles of main line and 1,659.45 miles of branch lines, or a total of 2,074.25 miles in Saskatchewan; the Canadian Northern Railway had 400.67 miles of main line and 1,653.93 miles of branch lines, or a total of 1,854.60 miles; and the Grand Trunk Pacific Railway had 415 miles of main line and 267.67 miles of branch lines, or a total of 682.67.

This gives a grand total for the province of 4,611.52 miles, made up of 1,230.47 miles of main lines and 3,381.05 miles of branch lines.

Throughout the whole season there was a shortage of labor, and much time was lost on account of the unsettled weather. When harvest time arrived the high wages offered by the farmers rendered it impossible to keep the construction gangs at full strength. The steel rail mills were slow in making deliveries, on account of the heavy demand for this material. These and other causes all contributed to delay construction, with the result that the number of miles of railway added during 1912 was much less than in other recent years.

AMERICAN WOOD PRESERVERS' ASSOCIATION.

Abstracts of papers delivered before the ninth annual meeting held in Chicago, January 21-22-23, 1913.

NATURAL AND ARTIFICIAL SEASONING OF DOUGLAS FIR FOR TREATMENT.

By Mr. F. D. Beal.

The above subject is one on which a large amount of knowledge is yet to be obtained.

Although we have been treating Douglas fir for about twenty-four years, we cannot say that we have yet developed a method of seasoning that could be considered wholly successful under all conditions.

In the first place, the wood being naturally hard and refractory in the seasoned state, sufficient penetration by pressure treatment alone could not be obtained to insure the full protection of the wood for a sufficient length of time to make the treatment a paying proposition. Therefore, it was decided very early in the history of the Pacific Coast treating, that some means of artificial seasoning would have to be resorted to in order to prepare the wood for the reception of the preservative used.

Our first move was to take up the steaming and vacuum process with which you are all more or less familiar; that is, of turning saturated steam directly on the timber and raising the temperature to a point to insure the thorough heating of the interior wood and vaporizing all sap moisture, etc., and the writer used to think they were vaporizing the wood itself by the looks of all the pitch, resin, etc., that used to come out through the drains.

This was carried on until the maximum vaporizing point was reached. A vacuum pump was then applied, heat being maintained in the cylinder by the circulation of superheated steam through steam heater pipes in the bottoms of the cylinders. This vacuum and superheated steam was carried on until the balance of the moisture, etc., was fully extracted from the cylinder. In this manner the wood would take the preservative under pressure very readily, but the strength of the material was so impaired as to practically condemn it for use in structures.

Various other schemes were then tried out with very little success until in 1894 Mr. John D. Isaacs conceived the idea of trying out a modification of the "Boulton Method" of seasoning by immersion of the unseasoned timber in creosote oil, using the oil as a medium for conveying the heat to the timber, raising the temperature of the oil above the boiling point of water—thus vaporizing the moisture in the wood, allowing it to pass off through vent pipes into condensers through which cold water was circulated, but eliminating the use of any vacuum pump.

In this manner, the timber was dried or seasoned with a lower degree of heat and left in good condition for the reception of the preservative under pressure.

This method of seasoning has been carried on continuously on the Pacific Coast now for over twenty years, and although there is some decrease in strength, the material is in much better shape and lasts longer than that air-seasoned or treated by steam.

At the present time experiments are being carried on at St. Helens, Oregon, at the St. Helens Creosoting Company's plant, on the seasoning of ten thousand Douglas fir ties. These experiments are being carried out under the direction of Mr. George E. Rex, of the Santa Fe Railway. The ties were selected and five thousand of them weighed. The ties that were weighed were tagged and numbered, record being taken of the same. They were then placed in the water during the months of May and June, 1912 They were cribbed in cribs of about sixty ties to the crib, but instead of being cross piled in the cribs they were all laid one way, separately, with one-inch strips nailed to the ties, the reason for this being that it was desired to place the ties in running fresh water with the ties lengthwise up and down the stream, thus allowing the water to pass through the entire length of the ties.

These ties were left in the water until about September 15th, when they were taken out and the five thousand reweighed to ascertain the amount of water absorbed. They were then piled in open piles to air season. When it is found that the ties are sufficiently dry they will be treated by pressure process alone, without any artificial seasoning.

The object of these experiments is to try and find some process of seasoning without the application of heat in order to retain the natural strength of the wood as much as possible, the theory being that, as with Douglas fir when sawed into lumber and immediately piled in the open air, the wood checks and splits excessively; also, when thoroughly air dried the wood becomes so hard that it is impossible to get any penetration with the preservative. Therefore, the idea of putting the ties in the water was to allow them to water season and wash out all of the saps and natural wood moisture; to then pile them in open piles, allowing the moisture that was absorbed during the immersion to evaporate. In this manner the wood would not check or split.

At the date of this writing, November 20th, 1912, the theory of eliminating the checking and splitting is working out admirably. The ties as yet show no evidence of splitting or checking in any manner.

One pile of the ties was selected to be weighed every fifteen days to determine the rate of seasoning.

It was at first intended that the ties should be treated in the creosoting cylinder about November 1st, but on account of the excessively heavy and continuous rain for the past month the seasoning has been retarded and it has now been decided to allow the treatment to go over until about February 1st, 1913.

At the time of the treatment of these ties there will be present engineers and representatives from a great many of the railway companies throughout the United States, and we herewith extend an invitation to all members of the association to be present at St. Helens, Oregon, at this time, as we expect to develop something new for the seasoning of Douglas fir.

LAYING WOOD BLOCK PAVEMENT.

By H. S. Loud.

A contract for wood block pavement usually includes regulating the entire portion of the street to be paved, removing the old pavement, regrading the street, readjusting other types of pavement at intersections, setting new curb, dressing and resetting old curb, resetting catch basins, manhole frames and sewer heads, putting in new concrete foundation and laying the wood blocks.

Before ordering the paving contractor to commence work the city should see that all sewer work, water and gas pipes, underground conduit, street railway tracks, etc., have been put in good repair.

The city should insist that all backfill over such trenches as are opened be thoroughly and properly tamped.

The first operation is to set the curb.

Then the old pavement is removed and the street graded from curb so that the subgrade shall be exactly parallel to the finished grade and as much below same as the added depth of the wood block, the cushion and the concrete foundation. Soft or spongy places should be dug out and refilled with proper material. Unless the subgrade is quite solid it should be compacted by tamping or rolling with a heavy roller.

Upon this subgrade must be placed a concrete base, finished with a commercially smooth surface, and from four to six inches in depth, depending on the traffic and the condition of the subgrade. The concrete should be constructed in accordance with the materials and methods described in the specifications reported by the committee on cement adopted January, 1912, by the Association for Standardizing Paving Specifications.

In general the question of concrete has been worked out in each locality according to the materials available, and all that is needed is a good substantial base that is deep enough to carry the traffic.

Great care should be taken to secure a smooth surface on the concrete and to keep it exactly parallel with the finished grade.

Three longitudinal rows of grade stakes should be put in. One row down the centre of the street and one row midway between the centre and each curb. The stakes in each row should be about fifteen feet apart. With a good concrete gang this should be sufficient, but with an inexperienced gang the stakes in each row should be closer. On a wide street intermediate rows should be added. For very particular work masons' lines may be stretched along the longitudinal stakes.

After the foundation has set thoroughly, a layer of sand, or of sand and cement (1 cement to 4 sand) is spread over it and struck to a true surface exactly parallel to the top of the finished pavement and as many inches below same as the depth of the blocks to be used. This cushion or bed is simply a means of securing a perfectly uniform surface for the blocks to rest upon, and if the concrete has been properly laid should not average over ½ inch in thickness for mortar cushion and one inch for sand cushion. Whichever material is used should be laid dry and free from pebbles. If it is not perfectly dry it should be combed out with a rake, smoothed to an approximate surface, rammed or rolled and then struck with a drawing board.

There are two ways of striking the even surface required. One of the most common, but not the best, is to use flexible strips of wood or iron about three-eighths of an inch thick and four inches wide. These strips are set parallel to each other and about eight or ten feet apart, running from curb to curb. They should be imbedded in sand throughout their length, so that their top surface shall be parallel to the grade of the finished pavement and as many inches below same as the depth of the blocks to be used. The space between the two strips having been filled with a bed material, a true and even top is struck by using an iron-shod straight-edge on the strips as a guide, and as soon as the bed has been struck the strip which would interfere with laying the block shall be removed and its place carefully filled in with cushion.

The other and better method is to draw the bed in a direction parallel to the curb. Instead of flexible strips pieces of wood are used about twelve feet long and as wide and thick as the blocks are deep. These guide pieces are set parallel to the curb and to each other and are bedded on cushion material throughout their length so that their top surface shall coincide with the top surface of the finished pavement. One such guide is placed next to each curb and one is set one foot off the centre of the street. The space between the guides having been filled with cushion material, a true and even top surface is struck by using an iron-shod templet which is one foot longer than one-half the street width. This surfaces one-half the bed. The middle guide is shifted one foot off centre in the opposite direction and the other half of the bed struck. The guides are then removed and the bed is ready for use without the necessity of any hand fluting. The templet has notched ends as it is drawn over guides which are level with the top of the finished pavement, while its drawing edge is below that level by the depth of the block. Shoes should be fastened to each end of the templet to prevent its tipping while being drawn.

The second method is much superior to the first. It is more accurate, quicker and cheaper.

The question as to whether a sand or mortar cushion should be used is a matter of opinion, as both have given excellent results. In general sand gives a true cushioning effect, and the blocks do not have to be rolled as soon after paving as when a mortar cushion is used. The mortar cushion is better on appreciable grades especially in car track work. If mortar cushion be used the pavement should be sprinkled sufficiently during the rolling of the block to supply water to set the concrete.

English and French practice does away with a soft cushion. The concrete base is floated over to a depth of one inch with a one to three mixture of cement and sand laid to the proper crown. This is allowed to set thoroughly.

After the bed is prepared provision for expansion joints is made by placing boards along each curb. These boards should be about six inches wide and thicker on one edge than the other, so that they may be easily withdrawn after the blocks are paved. They should leave an inch and one-half space to be filled with bituminous material.

Alongside the above board three rows of block should be paved parallel to the curb. On the rest of the street the block should be laid at right angles to the curb. Blocks should be laid neither too tight nor too loose—about so that before the joints are filled any block can be easily pulled out of the pavement by jabbing a knife blade into it.

The blocks should be paved with the grain vertical and all joints broken by a lap of at least three inches.

With streets of light traffic it is desirable and necessary to have transverse expansion joints. These should be about three-quarters of an inch wide and placed from 25 to 50 feet apart.

After the blocks are paved the surface should be rolled with a roller weighing from 2½ to 5 tons and then inspected, and any lack of uniformity or unevenness corrected by taking up and relaying the defective portion.

The joints should then be filled with clean sharp sand, perfectly dry and free from pebbles. The sand should be thoroughly broomed until the joints are completely filled. The surface should then be covered with one-half inch of sand and traffic admitted to the street. It will take about ten days under traffic for the joints to take up all the sand they require.

In England where they use a smooth hard concrete surface they lay two courses of hand-dipped (in pitch) block parallel to the curb. A space of from one to two inches is left between the curb and the wood block to allow for expansion; this space is filled with clean puddled clay or approved bituminous filler. After laying the blocks a mixture of boiling pitch and creosote oil is poured over the whole surface and well forced into the joints and the surplus scraped off with wooden or rubber squeegees. A top dressing of crushed stone, passing a ⅜-inch screen, is then spread over the pavement.

In some places the top of the concrete is flushed with a bituminous material just before paving.

It is desirable that wood block be paved into the street as soon after treatment as possible. For this reason it is well to have the concrete laid before the blocks are received and thus be able to deliver them directly to the pavers.

In case this is impossible, the blocks should be tight-piled along the line of the work and they should be protected from the sun by wet straw, tarred paper or similar means and sprinkled with water from time to time to keep them from drying out too much. In piling block alongside of the street it is desirable to make the piles as high as convenient, for they will occupy less sidewalk area and interfere less with pedestrian and delivery traffic.

In paving, care should be taken to keep the courses straight and at right angles to the curb. Special attention should be given to paving around manhole heads, street car tracks and other iron work. Blocks should be paved against a vertical surface; to get this it is necessary with rails and may be necessary with other iron work to plaster the abutting face with a rich mixture of sand and cement. It is absolutely necessary adjacent to all such iron work that the cushion be specially tamped and thickened so that the block when paved shall be from 3/16 to ¼ inch above the wearing surface of the iron. Traffic will bed these blocks down to the level of the iron in a short time.

Block paved as already outlined is all right for streets having a grade not over three per cent. Streets with greater grades should be paved with a ⅜-inch groove between each row of block. The best way of doing this is to separate each row with a creosoted strip ⅜ inch thick. The width of these strips should be one inch less in depth than the block, so as to leave a groove one inch deep. These grooves are sometimes filled with pebbles and pitch. Wood block should not be used on grades exceeding six per cent. except in special cases.

With wood block pavement the crown should be as light as possible; just sufficient to shed water freely.

Car-Track Work.—It has already been pointed out that in paving against street car rails the blocks should be set against a perpendicular surface and also paved about ¼-inch high. Between the car tracks it is possible to use this construction with a Trilby rail. With the old form of girder rail this may be done, too, but the surface of the block within the car tracks will be on a level with the wagon wheel tread of the rail.

A great many street railways use T head rail. Blocks may be paved against such rails by plastering the surface and paving low enough to allow the flange of the wheel to pass freely. This means that the pavement within the tracks will be about one inch below the abutting pavement. Or the rail may be plastered and the blocks paved from rail to rail at the same level as the surrounding pavement; the blocks that set up against the rail in this case must have one corner chanpfered off to permit the passage of the wheel flange. Instead of plastering the side of the rail, creosoted strips are often used. Specially formed blocks are also used.

Many bridges are paved with wood blocks Some of them have concrete roadways on which the blocks are paved substantially as outlined previously. Many have plank floors and some iron floors. Planks should be creosoted, surfaced to an even thickness and laid smooth. Blocks may be laid directly on the creosoted plank, but it is often desirable to cover the plank first with one or two layers of tarred paper. The joints between the blocks should be filled with bituminous filler. This filler is recommended for all bridge, shop and stable floors.

Whenever there is a plank foundation laid on a grade or with traffic all one way, it is desirable to fasten angle irons across the roadway every twenty feet or so to prevent the block from creeping.

In regard to the blocks themselves: they are made either three, three and one-half or four inches deep; their width varies from three to four inches, but all blocks in one improvement should be of the same width. Three-inch block should be limited in width between three and three and one-half inches. Deeper block should be four inches wide. The average weight per yard of wood block is 140 pounds for three inches deep; 165 pounds for three and one-half inches deep and 187 pounds for four inches deep.

As to treatment: twenty pounds per cubic foot of wood has been the standard in this country, but for heavily travelled streets 16 pounds is sufficient.

Long-leaf yellow pine and Southern black gum have been the standard woods for streets of heavy traffic. In the West they have also used Norway pine and tamarack, and in the East and South North Carolina pine is coming into great favor for residential streets, for those of moderate traffic and for streets with heavy grades. North Carolina pine more nearly resembles the creosoted wood used in Paris and London than does the long-leaf; it wears uniformly and permits crushed trap rock to be rolled into its surface, making it less slippery than long-leaf. It is ideal for state highways, where if used it should be laid with bituminous filled joints. It is also extensively used for factory floors.

In regard to the labor necessary to lay wood block pavement, leaving out the preliminary work of excavation, foundation, etc., I would say that an ordinary paving gang consists of a foreman, about four pavers, a bed-maker and his helper and some twelve laborers. The yardage that such a gang will lay in a day depends largely on local conditions, but they should pave in the neighborhood of five hundred yards per day on continuous work. The above men do not include those engaged in carting and piling the blocks on the sidewalk or the rolling.

THE TREATMENT AND CARE OF FLOORS.

By Geo. W. Saums.

In the very much larger demand for the preservation of cross ties, poles, and what might be termed wood for heavy duty, the application of preservative methods to wooden flooring has been neglected and has apparently received little or no attention at the hands of those who have been giving special and particular attention to the larger subject.

Everybody needs floors, and therefore as a matter of fact the care and preservation of floors is in reality also a large subject and worthy, it has always seemed to me, of more attention.

Wood used for flooring has no different characteristics from wood used for any other purpose, and is subject to precisely the same rotting conditions as when used for heavier work, and mainly, perhaps, because each individual floor in itself does not represent a very large outlay of money for maintenance, the fact that the aggregate of all floors does run into a large cost has been neglected, and unfortunately neglected to the extent that under present conditions concrete and other composition floors are rapidly being substituted for wood, especially where any heavy wear is likely, even though these compositions can never be as entirely satisfactory as a good wood floor, if that floor could only be preserved in good condition for a reasonable length of time.

Obviously, in addition to rot, it is necessary in floors to consider splintering and buckling, and it does not require a combination of any two or more of these difficulties to make it necessary to relay a floor. Upon the appearance of any one of them it means that sooner or later a new floor must be laid.

On account of these well-known troubles and the known properties of wood, in so far as their various properties are known, the use of wood for flooring has become more or less standardized—that is, maple for indoor floors where the wear is great and as long life as possible, with a good appearance, is required, irrespective of first cost. Oak, ash and chestnut in residences and ordinary offices, where there is no heavy traffic and pine for heavy traffic or where it may be necessary to offer more than usual resistance to dampness or other weather conditions. It would be impossible to cover the different variations in in the kind of wood used for floors according to individual whim or special conditions, for there are as many exceptions as there are rules on the subject, each of the the above kinds of wood, however, seeming to have more or less of a peculiar applicability to the work required, and proving in its cost of maintenance or replacement, expensive or otherwise, according to the knowledge of conditions possessed by those responsible for laying each floor.

Maple is naturally first in favor and most frequently used. It is, however, also most expensive, and in some respects the most unsatisfactory floor. The average quality of maple being used for flooring to-day is not as good wood as the maple that was used twenty years ago, and there are now maple floors that have been down for twenty years which are in better condition than floors that have been down only a few years. Irrespective of quality, however, maple is desirable for indoor floors chiefly on account of its good appearance, long wearing and non-splintering qualities, due to the close fibre of the wood, this close fibre at the same time seeming to be the reason for most of the trouble with maple floors, as on that account it holds moisture longer, and, unless it has been treated in some proper fashion, will in from two to five years buckle, many times even to such an extent that tongue and groove separate, nail heads pull through, and the floor becomes unsightly and unsafe for traffic. Maple also seems to be peculiarly subject to rot where it is in contact with artificial heat supplied from radiators or steam pipes. It is on account of this extreme sensibility to dampness that maple is seldom used for outside flooring.

Ash, oak and chestnut will all quickly splinter, if subjected to any heavy wear.

Pine, second only to maple in the extent of its use for floors, is perhaps the cheapest and least expensive to maintain, and can be used where traffic is heavy, and as it rarely becomes buckled, offering better resistance to weather conditions, can, aside from the matter of appearance, be used for floors where none of the other woods would do so well.

Pine, however, will splinter, and after commencing the splintering advances rapidly, making the cleaning of the floor almost impossible, and very quickly rendering it unsafe for traffic.

In floors, all of these woods are just as subject to rot as they are when used for other purpose, and there does not appear to be any peculiarity in the way rot starts in a floor, the conditions and results being much the same in flooring as in any other wood, and the most expensive-economy practiced is to lay a new floor over an old one that is dry or rotted, the rot from the old floor simply penetrating the new floor with a greater degree of rapidity, and seemingly also after an old floor is covered with a new one without the old floor being taken up, the rot penetrates the rafters and beams more quickly.

The desirability of treatment for floors to prevent splintering, rotting and buckling has, of course, been recognized, and different ways have from time to time been tried, and in my experience most of these different ways have been not only unsuccessful, but many of them positively injurious, one very prevalent way being the application of boiled linseed or cottonseed oil when the floors are laid. This idea is all right as far as it goes, but I have never found that it was permanent. It does not seem to penetrate the fibre, but, remaining on the surface, hardens, and then the traffic soon causes it to scale off in a light yellow powder, leaving the floor no better able to resist rot and splintering than before application. A combination of linseed or cottonseed oil with turpentine and wax is in the same class, the turpentine only penetrating the wood, but that soon evaporates, and the traffic then causes this to scale off in the form of a dark brown powder. Paraffine wax oil seems to be more or less injurious, as this apparently destroys the life of the floor, causing a rot of a peculiar character, noticeable by small pieces of wood breaking off under wear.

Creosote and similar real preservative materials are not practical for the great majority of indoor floors for obvious reasons, and it would seem, if this field is to be covered, that it can only be through the medium of a material that is an actual preservative, that will cause the floor to which it is applied to resist dampness and splintering, and that can be applied to the floor either after it is laid or at least applied to the flooring of the building or the place where it is to be laid.

Statistics are not obtainable as to the amount of wood flooring annually consumed, but the quantity is so great that any practical way, at a cost that would be commercially practicable, to add to the usefulness and the life of wood flooring is well worth careful attention, and the concrete and composition flooring has not proven so universally satisfactory under any and all conditions, but that wood flooring will be well able to hold its own in competition with these other materials, if the ordinary trouble of a wood floor could be materially modified or overcome.

TIMBER FOR CREOSOTED BLOCK PAVING.

By Harry C. Davis.*

The success of a wood block pavement depends upon four fundamental principals. These are:

First. The quality of wood from which it is manufactured.

Second. The character of the oil used for preserving the wood from decay.

Third. The method and manner in which the blocks are treated.

Fourth. The excellence of the construction of the pavement.

While it is probably true that all of the first three of these principals are of equal importance, and the fourth of major importance, this paper has to deal only with the first, or the quality of the wood selected for the pavement. No matter how proper may be the selection of the wood, the oil or the manner of treatment, the pavement will be a failure unless the construction work is properly done.

Failures of street pavements of all kinds are frequently attributed to causes which have nothing to do with that failure. For instance, the writer is familiar with a certain street in the city of Chicago where black gum was used and the timber condemned and stricken from the specifications because of defects appearing, which were attributed, probably without the slightest reason, to the wood itself.

It is also equally true that faults sometimes exist in one of these fundamental principals which are not directly charged to it. Take, for instance, "weeping" or "bleeding." This has universally been attributed to the nature of the oil used in impregnating the blocks, and but few engineers have attempted to charge it to any other cause.

*Manager Paving Department, Chicago Creosoting Co., Chicago, Ill.

About three years ago the writer heard Mr. Andrew Rinker, city engineer of Minneapolis, state that there had been no trouble from "bleeding" in the six or seven hundred thousand yards of creosoted blocks they laid in that city. Since that time there has been a change made in the timber specifications, while the oil is practically the same as was used prior to that time. Now there are complaints of "bleeding" in Minneapolis. As usual, this defect has been attributed entirely to the oil, and so far as the writer knows no one has even suggested that the wood is in any way responsible for the condition.

In selecting a wood for paving purposes, three things should be taken into consideration. These are:

First. The adaptability of the wood to the purpose designed.

Second. The availability of the wood selected.

Third. The commercial conditions surrounding the wood selected.

By "adaptability" is meant both the probable service that will be given by the blocks manufactured therefrom, as well as the natural characteristics of the wood with respect to the manufacture of the blocks.

The writer of this paper does not intend to enter into any extended discussions of the natural characteristics of the various woods available for paving purposes. It is thought sufficient only to touch lightly upon this phase of the subject, in the hope that some of the members who are practical treating engineers will more extensively bring out these points.

A pavement, be it wood block, brick, stone, asphalt or tar, is laid for two purposes—namely, to facilitate traffic and to increase sanitation. The only feature worthy of consideration from the standpoint of this paper is that relating to traffic, and more particularly with reference to the effect of traffic upon the pavement. As this is true, it is necessary to select a wood which is sufficiently strong in texture to withstand the effects of the traffic and give a long life to the pavement.

Engineers, as a rule, are prone to be entirely too strict in their requirements. For instance, engineers of this country have been making long-leaf yellow pine the standard of perfection in a paving block. This wood has been used in probably seventy-five (75) per cent. of the creosoted block pavements laid prior to 1911, when they decided that a short-leaf pine might be used if of close growth. The change was a wise one, inasmuch as short-leaf pine, while not so strong a wood as the long-leaf, is sufficiently strong for a paving block.

There is a great deal of difference in the characteristics of the two woods. Long-leaf pine, according to Sargent, weighs 43.6 lbs. to the cubic foot, against 38 lbs. per cubic foot for the short-leaf. The specific gravity of the one is .70, against .61 for the other, while the modulus of rupture of short-leaf pine is barely 75 per cent. of the long-leaf.

The foregoing is cited simply to show that it is not necessary in selecting a wood for paving purposes to require one of the greatest possible strength, but simply to call for a timber of sufficient strength to withstand the stress to which it will be subjected under traffic.

Following this principal you will find that there are several commercial woods available for paving purposes, any of which are sufficiently strong for the purpose and elimination must come through the more technical features of wood preservation, such as the adaptability of the wood to treatment, and its power to withstand decay after treatment.

Experience has proved that in the Central West we have at least four woods which, when tested by every possible requirement, are suitable for paving purposes. These woods are Southern yellow pine, tamarack, hemlock and maple. The writer has had no opportunity to study the Norway pine. One street paved in Chicago with black gum is not considered a sufficiently conclusive experiment to warrant one to form a definite opinion.

The writer is thoroughly convinced that each of the four woods mentioned is sufficiently strong to withstand the heaviest of traffic, and from actual experience knows that each is adapted to treatment Observations made at our plant during the past year show that maple is the wood most easily treated, followed closely by tamarack and hemlock, all three greatly outclassing yellow pine in this respect.

Before proceeding to the other phases of the subject, I want to give you a few observations I have made of the results obtained by the use of these woods. For the past ten years the city of Chicago has confined its wood block pavements almost entirely to yellow pine, in fact all the streets laid prior to 1912 were yellow pine with two exceptions. These were about 1,500 yards of Southern black gum and about 8,000 yards of street car right-of-way paved with tamarack. In the past year we have laid a test intersection with maple, and about two miles of tamarack blocks. The yellow pine has given excellent satisfaction on some of the heaviest traffic streets in the country. We have one street in the loop district in Chicago paved six years ago with yellow pine, and certainly no one can say there has been the slightest failure due to any defects in the timber.

About five years ago The Kettle River Company, of Minneapolis, sold to the Chicago Railways Company some tamarack blocks which were used in paving the right-of-way on Dearborn Street, between Van Buren and South Water Street. Although the construction of this pavement is open to considerable criticism, especially the treatment around the tie rods, yet the pavement is in excellent condition to-day, and shows just as good results as have been obtained from yellow pine blocks.

A little more than a year ago our company furnished enough hard maple blocks to lay the intersection of Madison Street with Fifth Avenue, one of the heaviest traveled spots in the city of Chicago. It is estimated that the daily vehicle traffic on Madison Street is eight thousand, while that of Fifth Avenue is over five thousand. Pounded by traffic from four directions, these blocks do not show the slightest sign of wear. In fact, so satisfactory was the result that the Chicago Railways Company purchased its entire supply for 1912, specifying maple.

With reference to hemlock, I will simply call your attention to the results shown by this wood in the test pavement in Minneapolis laid under the supervision of the United States government. In a seven-year test, hemlock shows only a sixteenth of an inch more wear than the strictly long-leaf yellow pine. In compensation for this, I am reliably informed that the relative quality of yellow pine used in this test was better than that of any other wood placed in the pavement.

Certainly these instances would prove that so far as the strength of the four woods mentioned is concerned, that the engineer should have little or no hesitation in making his specification open to all. There is no doubt that hard maple is the strongest of the four, followed next by the yellow pine, and then by tamarack and hemlock. But each is sufficiently strong for paving purposes.

Little can be said on the subject of the availability of the wood to warrant the selection of any wood for paving purposes. It is necessary to assure oneself that the available supply is sufficient to fill the demand, and in considering this phase of the subject it is well to look to the future. The wood that is plenty to-day—when the pavement is planned—may be scarce to-morrow, when the pavement is laid.

One of the most important things to take into consideration is the commercial conditions surrounding the timber selected. A wood block pavement, or in fact any pavement, must be constructed as cheaply as possible commensurate with the quality required. This means that careful consideration must be given to the commercial conditions surrounding the timber

There is perhaps no better illustration of the danger involved in this connection than was evidenced in the city of Chicago in 1912. Every ordinance called for Southern yellow pine or woods equally good for paving purposes. As all know, the yellow pine market early in 1912 joined the aviation craze, and Lincoln Beachy lost every laurel he ever won. The sky was the limit, and, as a result, wood block pavements broke all records for high prices to the consumer and small profits to the manufacturer. Our company was more fortunate because of the supply of tamarack timber, which was not affected by the airship mania, and we sold every foot we had, and could have sold four times as much more had we laid in a larger supply earlier in the year.

While these pavements were soaring and being damned by every property owner who had to go up and plank down his hard-earned cash to pay his assessment, we were vainly struggling with the city to permit us to deliver hard maple, which could be purchased at a considerable lower price than yellow pine, or even tamarack. But the policy of the city was against letting down the bars, and the taxpayer paid the bill.

It is not the intention of the writer of this paper to plead for any particular wood. The writer has no favorites, and is so situated that he can furnish any wood that has yet been used as advantageously as any competitor. I am a pretty good Democrat, at least to the extent of crying free trade. I believe in an open specification. Put the Northern and Southern woods into competition and then give the taxpayers the benefit of that competition. Do not put yourself at the mercy of the Southern floods or Northern thaws. Play both ends against the middle with a stringing bet near the centre, and you will have as near a system that will beat the game as it is possible to find. Any of the four woods mentioned in this paper is good enough for a street pavement. Therefore, get the one that is most available, and that is the one that will be the cheapest.

ADZING AND BORING TIES AND THE COST OF INSTALLING PLANTS OF THIS KIND.

By James A. Lounsbury.

Railway track construction in this country has never, for any long period, been adequate to the demands made upon it. Traffic, wheel loads and speeds have continually outrun all efforts to keep the sub-structure equal to the requirements. Track improvement programs providing for a liberal margin in carrying capacity have been overtaken and passed by the growth of traffic almost before the work was completed, and therefore little relative gain has been made. This has been due to some extent to the fact that such improvements have been made under pressure, and time has not permitted the close investigation and study of the means and methods necessary to produce the highest ultimate economy, but the necessity of doing the best possible with the amount of money available for the work has probably been the chief limiting factor.

The era of extensive railroad building is practically past and future progress will be along the line of intensive development, in which the quality will be higher as the quantity grows less. The continually narrowing margin between income and operating expense is forcing railroad officials to consider details of economy which heretofore have not appealed so strongly to them.

Probably the most important step that has been taken in this direction is the rapidly growing practice of chemically treating ties in order to secure the longest serviceable life for the smallest tie investment. But the chemical treatment cannot show its maximum efficiency with the prevailing methods of handling the ties when putting them in track. The folly of paying twenty to thirty-five cents per tie for chemical treatment and then to so mutilate them by hand adzing and spike driving as to greatly reduce the beneficial effect of the treatment is too obvious to require argument.

Machine Adzing.—Of the 150,000,000 ties used annually in this country, approximately 74 per cent. are hewn and 26 per cent. sawed. Hewed ties are never straight and the face side is never a plane surface. Sawed ties are straight when first made, but go "into wind" during seasoning. This is particularly true of many varieties of hard wood. The consequence is that the rails when laid have an insignificant bearing on the tie, throwing the weight of the supported load on a very restricted area of the rail base and introducing very serious stress factors into the rail problem. Hand adzing is resorted to commonly to correct the defects in the tie surface, but this is at best only a partial remedy, and its effect on the impregnated part of the tie is destructive. The advantage of having a full and perfect bearing for the rails over the whole width of the face of every tie is evident. It reduces rail cutting, decreases the danger of half moon breaks in rail bases, reduces disturbances of the ballast and gives added firmness and stability to the track. Where plates are used it is a practical necessity to give them a full bearing on the ties, as the increased surface makes it more difficult for them to properly seat themselves under traffic. If their bearing on the tie is not parallel with the bottom of the rail they increase the danger of rail breakage, as they form an anvil upon which the impact of rapidly moving loads is received. If the point of support is along one edge of the rail base only the danger to the rail is apparent.

Boring for Spikes.—Many tests made by the United States Bureau of Forestry, by several universities and independently by a number of the railroads have demonstrated conclusively that common square spikes have increased holding power when driven into previously bored holes. These test reports are too voluminous to be reproduced here, but your attention is directed to tests made in August, 1909, at Purdue University, under the auspices of the Bureau of Forestry, by Mr. J. A. Newlin, Engineer of Timber Tests. Also to very exhaustive tests made under the direction of Mr. R. I. Webber at the University of Illinois in 1906. Conclusive tests have been made by the A., T. & S. F. Railroad, but I do not know that they have been made public. These records agree as to the main facts, but the difference in the conditions surrounding the several tests makes exact comparison difficult. It is sufficient to note that the differences are in degree only. They indicate that in the oaks, beech, gum, long leaf and short leaf pine and Douglas fir the increase in resistance to vertical pull varies from 5 per cent. to 15 per cent. in favor of the spikes in bored holes, where the holes are ⅛ inch to 3/16 inch smaller than the spikes.

It is unfortunate that there are almost no reliable data showing the comparative resistance to lateral pressure of spikes driven directly and those driven into previously bored holes. This is of even more importance than the resistance to vertical pull, as upon it depends the maintenance of gauge and the prevention of rail spreading under high speed trains. It is probable that the resistance to flange pressure is increased in much greater proportion than the resistance to vertical pull, because the spike in a bored hole has a backing

of solid wood instead of being surrounded by torn and broken down fibres, as is the case when driven directly.

The use of screw spikes, of course, makes pre-boring absolutely necessary. A number of roads are already committed to this form of rail fastening, and its extended use is only a matter of time. At present probably 75 per cent. of the ties that are bored are for square spikes. The possession of a convenient means for cheaply and rapidly doing the boring will cause the early adoption of the screw spike on many roads which would be slow to take it up under other conditions.

Of chief interest, however, to the members of this association is the great advantage from a treating standpoint of having the adzing and boring of ties done before the treatment takes place. The vital points of a tie are the parts under the rails and contiguous to the rail fastenings, and this is where the impregnation should be most thorough. In air seasoning the ties become case hardened on the outside, and this hard skin is more difficult of penetration than the portion immediately beneath. In adzing previous to treatment this more resistant portion is removed for a distance of 12 inches to 14 inches in length for each rail bearing. This permits the chemical to penetrate more freely transversely to the grain. The holes bored for the spikes give the chemical free entrance to the interior, allowing it to radiate from each hole by end grain penetration, thoroughly saturating these portions even when the tie as a whole is not given a heavy treatment. How much this saturation of the parts of the ties subject to earliest failure will increase their life cannot be measured until sufficient time has elapsed to allow accurate comparative data to be obtained, but there is no doubt that it will greatly increase the efficacy of the treatment and produce results far out of the proportion to the cost of the adzing and boring operation. It is stated by the railroad engineers who have had several years' experience with adzed and bored ties that the saving in time and labor in putting the ties in track is sufficient to pay the cost of the adzing and boring, leaving all the other advantages a net gain.

Adzing and Boring Machines.—The adzing and boring of ties has been standard practice in Europe for upwards of twenty years, and the results have proved its economy. Owing to the abundance of cheap labor in those countries, the development of machines of the highest labor-saving capacity has not been rapid. Their ties are more carefully made, and therefore machines are not required to meet such wide variations as in this country. In England the majority of ties are sawed from dimension stock and vary little in size. A range of 1½ inch difference in thickness is all that is provided for in their machines, while ours must be designed so that ties from 5 inches to 10 inches thick, and from 7 inches to 14 inches wide, may be run promiscuously. Again, their ties being practically of the same width no provision need be made for centering so that the holes will always be properly placed in the face of the ties. With our extreme variations in width, and the fact that no two ties are alike in shape, that crooked and straight ties must follow each other through the machine, makes it necessary that they be centred over the boring bits so that the holes shall be accurately placed in relation to the centre line of the face of each tie. In other words, the machine must take ties as they come, of all sizes and shapes, and automatically adjust itself to variations and irregularities, without human aid and without decrease in its rate of production.

Installation.—Two distinct patterns of adzing and boring machines are built for different methods of mounting. One is designed for installation on a stationary foundation, and the other, a more compact form, for mounting in a car. As more machines are specified for stationary mounting, this type is known as the Standard pattern. It is more open in design and accessible in its working parts than the more compact car type.

The question of which method of mounting is preferable must always depend upon yard and plant conditions, and each case must be decided upon its merits. It is probably true, however, that there are more treating plants in which the stationary mounting will give the higher economy in operation than those in which the movable type will give the better results.

The location of the stationary machine in relation to the retort house, power house, etc., in the case of plants already built, must, of course, be governed by the space that may be available, because it must be made to fit into conditions as they exist. In laying out a new plant the location is subject to control, and can be made where the least switching and handling of ties will be involved.

Wherever possible the machine should be placed between the stacking yard and the cylinders, so that all ties must pass it in their movement between those points. The trackage (narrow gauge) should be arranged so that trams from any part of the yard may be brought to the machine with the minimum amount of switching, and by-pass tracks must also be provided by which timbers not to be machined, such as switch ties, bridge timbers, piling, etc., can pass the tie machine without interfering with its supply. The tram track on the in-feed side of the machine should be about one foot higher than that on the delivery side, and should run out to a spring switch, so that an unloaded tram, given a start, will run by gravity past the spring switch, reverse its direction and return on the discharge side of the machine ready to be loaded for the cylinder. The space required between these supply and delivery trucks should never be less than 32 feet centres when the ties are to be taken from the tram and placed on the machine conveyor by hand. If the dumping hoist and the skid are employed the minimum distance between track centres is 46 feet. These dimensions apply only to the machine without the cut-off saw attachment. If the latter is required, six feet should be added to the track centre distances.

Where drainage will permit, the best form of foundation is to enclose a space 11 feet x 20 feet with a concrete wall, the interior being excavated and a cement floor laid. The side walls should be 7 feet to 8 feet high to give good head room below, as in the basement so formed the 50 H. P. motor for driving the machine is placed, together with the shavings exhaust fan. The top of the foundation should be about three feet above the grade line, making the actual excavation only about five feet deep. Steel I beams and 4 inch plank floor form the support for the machine. The weight of the latter is 20,000 pounds. This form of foundation is not always necessary, but is the most advisable when conditions permit.

Machines designed for mounting in cars perform the same operations in practically the same way, but, as stated before the dimensions are held down in order to bring them within the limit of width of a wide box car, having extra wide doors through which the conveyors extend. The original installation (two machines on the Santa Fe and one on the Northern Pacific) were all of this type.

The car used for this purpose should be of steel underframe construction, forty feet long 9½ to 10 feet wide, and of 40,000 pounds load capacity, and not less than 9 feet high in the clear. The cars are usually made self-propelling from the clear. The cars are usually made self propelling from the same source of power which drives the machine, a clutch being provided by which the machine is disconnected and the car axle drive thrown into gear when the car is to be moved. As the car is commonly designed to move about the tie yard

only, the speed is kept down to about three miles an hour. The principal movement being only from stack to stack, no higher speed could be used to advantage.

The kind of power to be used in these movable plants is often a somewhat troublesome problem. Electric drive is by far the most reliable and satisfactory if it is available. In yards using electric switching locomotives and strung with trolley wires the application of electric power is easy, but where this is not to be had resort must be made to some other source of power, usually a self-contained gasoline engine of about 60 H. P. installed in the car with the machine. This gives satisfactory results, but requires more careful management than would be necessary with an electric motor.

The track arrangement in a yard already laid out is, perhaps, the most important factor in determining the comparative merits of the stationary and car mounting. The usual system, a three-rail track between the tie piles, would make it necessary for the trams to follow directly behind the machine car, a position which is not convenient for loading by the machine conveyor, as a right-angled change of direction must be made by the ties in their progress from the machine to the tram. At the Somerville plant the Santa Fe people have a temporary track 60 to 90 feet long which is placed between the tie pile and the three-rail track, and upon this the machine car is placed. One rail length after the other is moved forward and laid ahead of the car. This leaves the tram track clear, and trams can be brought up to the side of the machine car, allowing the conveyor to discharge the machined ties directly into them. On the feeding side the ties are thrown down from the top of the piles and placed directly on the in-feed conveyor, so that one handling is saved by the movable machine arrangement. This, however, is offset by the time lost in changing the position of the car. As an average it is probable that about one-third more ties can be put through the stationary machine in a day than through the movable plant.

The subject assigned to me by your program committee included the cost of installation of machines for adzing and boring ties, but this is a difficult thing to cover without definite specifications. It is more an engineering problem than a manufacturing one, as the conditions are not the same in any two cases. The cost of the machine itself may vary as much as $1,500.00, depending upon what is wanted in the number of boring spindles, the length of conveyors, and whether or not the machine is to be provided with cut-off saws, branding device, dumping hoist and other special features. The cost of the power plant may also vary between wide limits. A steam engine or boiler, or a gasoline engine, costing much more than an electric motor. The building may be sufficient to protect the machine only, or may be large enough to cover both tracks and give protection to the tie feeders and loaders. One machine in the South is placed upon a foundation of heavy creosoted timbers laid on top of the ground and is covered by an open shed. Another on the Pacific Coast is placed on the end of a dock of piling, eighteen feet above the ground, into which the piles are driven. It is all a question of the governing local conditions, and how much money the purchaser is willing to spend. Some plants have been installed complete for $10,000.00, and the cost of others has run as high as $15,000.00, but in the long run the most thorough work is the cheapest, the saving in operation and maintenance paying large interest on the additional cost.

Does adzing and boring pay? It is believed that the increase in life that may be expected from ties adzed and bored before treatment will not be less than one-third, but to be conservative we will consider that it is only 15 per cent., or say 21 months of added service. In the case of a railroad using 1,000,000 ties a year, costing when treated, delivered and put in track 85 cents each, the total saving in tie renewals will amount to something over $100,000.00 a year. In comparison with the cost of equipment, is this not worth while?

THE PRELIMINARY TREATMENT OF TIMBER TO INSURE A MORE EVEN AND SATISFACTORY IMPREGNATION WITH CREOSOTE.

By David Allerton.

I will premise by stating that my title does not exactly state what I have in mind. I cudgelled my brains, but could not arrive at anything better in the limited time at my command, which is only a few hours. I must also say that what I may suggest does not conflict with any existing method or process. It was brought forcibly to my attention last spring, although it has long been a subject of study with me—that is, to find a method by which the great disparity often noticed, and in fact usually observed, of the great difference in the receptivity of various ties or timbers in a given charge. Mr. Goltra, in his work, has shown graphically the various degrees of absorption in a charge of ties as usually treated; of course, there will always, under any condition, be a considerable variation in a charge of carefully selected and sound ties and the same where structural timbers are treated, but is there not possible some method of preliminary treatment by which, without impairing the strength of the wood, the structure of the ties or timbers can be rendered more homogenous, so that with a given amount of oil the penetration will be more uniform? I assume that wood of the same species or variety, where the difference in penetration is marked, often as we have all observed in different parts of the same piece, that portion or piece which takes the oil readily would not be changed in its quality of absorption, but that the more difficult structure could be rendered more susceptible to impregnation, assuming, for instance, in the case of ties with a given quantity of oil—say the usual amount; 2½ or 3 gallons per tie—much more even penetration.

Of course, heat is a necessity in any mode of procedure, and the proper temperature and regulation will undoubtedly be the most important factor in solving this problem, as it is well known that to get good results from hot oil with cold wood is impossible (bear in mind I am not speaking of soft pine or other soft woods that take treatment under any conditions). But here arises another question. Suppose oil is dropped on the cold wood at a temperature of 190°F. and the heat in the cylinder again raised to 180°, how far into that wood is the temperature 180 degrees. That, of course, depends on the diameter of the pieces. With large dimension timbers it is a very little ways, unless a long time has been consumed, and even then the centre of the wood is very much cooler than the outside. This is one reason why large timbers such as 12 inch by 12 inch, or 12 inch by 14 inch, are very hard to treat. Taking this into consideration, I think the next most important factor will be air in conjunction with the heat in current, or compressed moist or dry, and perhaps attenuated by more or less vacua, as the situation will be found to demand, and in all probability the process will be varied somewhat for different species.

I assume that all will agree that the better seasoned the great majority of wood is the easier and more satisfactorily it can be treated, therefore I also assume that a preliminary treatment can be found, and very likely some of you have discovered the means by which, with the necessary adjuncts to the treating cylinder, or in accessory and less expensive cylinders, by use of which valuable time can be saved and the wood can be prepared to accomplish the best results.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., MANAGING EDITOR — A. E. JENNINGS, ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department, should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JANUARY 30, 1913. No. 5.

CONTENTS OF THIS ISSUE.

HEIGHT OF OFFICE BUILDINGS.

Canadian cities are rapidly approaching the conditions of congestion of traffic prevalent in cities of the United States. With the increase in land values the height of office buildings has gone up. Already the people are beginning to object, and drastic action must be taken in the near future in the larger of our cities if the sky-scraper is to be kept within reasonable limits.

In a recent article in a contemporary it was stated that the tall office building is the direct and logical result of congestion in large cities and the corresponding high values of building sites, which bring with them large rentals, justifying the greater investment necessary to increase the rental space by upward extension.

Since the fixed charges and maintenance of these buildings are extremely high, and few, if any, of them are constantly filled with tenants, the highest ones are almost invariably undesirable financial investments, and it is understood that exceedingly few of them in New York City return as much as 4 per cent. on the capital invested. Few of them are owned by private individuals, but in the majority of cases they are built by construction companies organized primarily to provide safe security for large sums of money loaned by insurance companies and other great corporations to the constructors of the building.

In New York, and probably in Chicago, it is likely that the maximum percentage of net returns for the capital invested is secured from buildings sixteen to twenty stories in height, of which there are scores, besides a considerable number materially higher, and some twice or three times as high, all of which have been erected within the last twenty-five years, since the production of structural steel and the high development of the passenger elevator, combined with improvement of fireproofing, have made their construction and operation possible and reasonably safe.

Their construction in small cities is seldom or never necessary, or justified by financial considerations, and it is more than doubtful whether the construction of these tallest examples is justifiable under any other consideration than that for a desire for notoriety, or whether they should be encouraged, or even permitted, in great cities, where alone there is much tendency to build them.

The principal objections to them are the enormous increase which their thousands of tenants cause in the congestion of the streets and of the traffic lines, the disfigurement of streets, the obstruction of light and air to the street and adjacent buildings, the great danger of disaster through panic among their tenants and the extreme difficulty or impossibility of adequately fighting fire in their upper stories. There is also a remote possibility of their destruction and fearful fatalities through earthquakes or cyclones.

The following is the text of a resolution presented before the Board of Trade of Toronto at their last meeting:—

> "The Council of the Board of Trade regrets exceedingly the frequent setting aside of the city by-law limiting the height of buildings in Toronto to ten stories, or one hundred and twenty-eight feet, and would strongly urge upon the city authorities the need for strict enforcement of such limitation, because, in the opinion of this Council, the steadily-increasing height of skyscrapers constitutes a serious menace to the public health, especially of those

whose work must be done in the lower stories away from the sunlight; it also adds unnecessarily to the already great congestion in the narrow down-town streets and unduly concentrates land values at or near a few leading corners, this concentration of values, in turn, making necessary still higher structures to meet the increasing ground rents.

"It is further resolved that a committee of the Board of Trade Council be authorized to wait upon the City Council and present this resolution."

As we have noted from time to time in these columns, these structures are not justified. The height of office buildings should not be fixed by the caprice of city councils. A fixed, inflexible rule should be followed, such as is in use in many parts of Europe, that the height shall not be greater than one and one-half times the width of the street on which it was erected.

McGILL GRADUATES' ADDRESSES WANTED.

A list is given below of a number of graduates of McGill University, Montreal, whose addresses are not in the University records. It will be greatly appreciated if information can be given regarding the addresses of any of these men, or any references which may lead up to the obtaining of the same. Communications should be addressed to Professor N. N. Evans, Secretary of Applied Science Graduates, McGill University, Montreal.

Graduates Whose Addresses are not Known.

1859—Crawford, Robert.

1860—Kirby, Charles H.; Walker, Thomas.

1889—Tuplin, Jas. P.

1892—Wainwright, Jas. G. R.

1893—Robert, Alph, M.A.; Simpson, Lincoln.

1894—Lambert, Frank.

1895—Dobson, Gilbert S.; McNaughton, Peter.

1897—Edward, John Ross.

1898.—Ainley, Chas. Newth; Atkinson, Wm. J.; Scott, James H.

1899—Pitcher, Norman C.

1900—Robertson, Philip W. K.

1901—Donaldson, Hugh Walter.

1902—Baird, Alexander; Jackson, Philip T.

1903—James, Bertram; Savage, George M.

1904—Cardew, John Haydon; Devlin, Cecil G.; McPhee, James McDonald; Roffey, Miles Herbert; Wilson, William D.

1905—Johnstone, George A.

1906—Livingston, Douglas C.; McIntosh, Robt. F.

1907—Brown, S. Barton; Gamble, Clark W.; Otty, George N.; Tupper, Fred McD.; Wright, George R.

1908—Cattanach, F. W. C.; Pratt, Austin Craig; Scott, George F.

1909—DeLancey, James A.; Grove, Humphrey S.; Hagne, Owen C. F.; Lundy, Thos. H. D.; Whyte, Herbert B.

1910—Cloran, J. H. D.; Elkins, Robert H. B.; Goodstone, Arthur S.; Reid, Archibald C.; Slavin, Reginald V.; Stuart, Aleg. G.; Sweetman, Samuel.

1911—Alward, Ernest T.; Murphy, William H.; Planche, Clifford C.

1912—Henry, Robt. A. C.; Sanderson, Chas. W.

TESTS OF PLAIN SEDIMENTATION OF SEWAGE.

Plain sedimentation of sewage instead of chemical precipitation has been tried with promising results at one of the large sewage-treatment plants of the London County Council. The following slightly condensed statement is from a recently revised pamphlet edition of the "Main Drainage of London," by Sir Maurice Fitzmaurice, chief engineer of the London County Council:

The main drainage committee conducted experiments at Barking during the months of May, June, July and August, 1911, with the object of finding out how the effluent would be affected if lime and iron were not added to the sewage, and if some alterations were made in the times and methods of cleaning out and removing the sludge from the precipitation channels. The usual interval between the successive cleaning out, or the "channel hours" of any one channel, is 60 hours. Shorter interval, viz., 30 hours, was adopted during these experiments so as to compare with the longer interval usually adopted. The general result of the experiments was that, as regards matters in suspension, almost the same purification was obtained without chemicals by reducing the channel hours to 30, as is at present obtained with the use of chemicals and with 60 channel hours. During the whole period in 1913, while these experiments were being carried on, no complaint was received as regards the condition of the Thames, notwithstanding that the summer of 1911 was exceptionally hot, and the amount of river water coming down was exceptionally small.

The experiments have been continued in the present year (1912) during the months of June, July and August, and the results obtained corroborate generally those obtained in 1911. The Port of London authority takes from time to time samples of the effluent discharged into the river, and during the months the experiments were being carried on they made no complaint as regards the quality of the effluent. In fact, the reports of that authority on the effluent during the experimental periods were of a more satisfactory character than either before or after, when the station was being run in the ordinary way.

The chemicals themselves add considerably to the amount of sludge that has to be dealt with, and it is possible that, owing to chemical combination, the bulk of the sludge may be increased by more than the amount of chemicals used.

If the use of chemicals were altogether discarded a very large saving in working expenses would result. The saving would not, however, amount to as much as the discarded chemicals would have cost, as the expense of increasing the flushing staff so as to reduce the channel hours from 60 to 30 has to be taken into account.

I cannot say exactly what the net saving would be, as the costs of lime and iron vary from year to year, but there is no doubt that, considering both outfall works, it would amount to between £15,000 and £20,000 a year [$73,000 to $97,000].

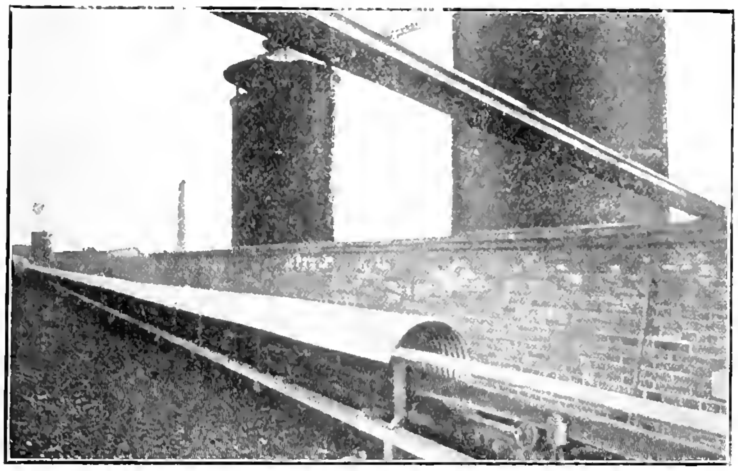
The results of the experiments made in 1911 were given in detail in a report presented to the Main Drainage Committee on November 23, 1911, and the results of the experiments made this year will be presented in a detailed report later on. I am strongly of opinion that one of the outfall works, at all events, should be run completely without chemicals for one year after the termination of the present contracts for chemicals; and from the data thus obtained it may be found advisable ultimately to discard altogether the use of chemicals for precipitation.

FOUNDRY CONVEYER SYSTEM OF MASSEY-HARRIS COMPANY, LIMITED.

The Massey-Harris Company, Limited, of Toronto, Ontario, have just completed the installation of a system of conveyers. These conveyers are installed for handling material in connection with their foundry and will greatly simplify and reduce the labor in this part of their plant.

A gravity discharge conveyer-elevator, 40 feet between centres vertically, and with a horizontal run of about 20 feet, is used, and coke is delivered to this by means of a hopper at the base, and is raised to the upper run from which it discharges to a belt conveyer serving the east cupolas, or into a hopper serving the charging cars of the west cupolas. This gravity discharge outfit is a very excellent type of conveyer-elevator for comparatively small capacities and it is used very extensively in coal pockets and fueling systems. It consists essentially of a series of "V"-shaped buckets carried between steel or malleable chains and attached rigidly to the links. The buckets on the ascending run are carried upright, so that the material is carried in the buckets, and on the horizontal runs the buckets push the material along in a steel or concrete trough. This arrangement allows for a very simple discharge at any point by merely opening a gate in the bottom of the upper trough.

The belt conveyer receiving from the gravity discharge is shown in the illustration. This conveyer is 18 inches wide and 350 feet between centres and runs horizontally along the top of the building for the greater part of its length.



Eighteen-inch, 350-foot Belt Conveyer at the Massey-Harris Company.

The method of housing the conveyer, employed by this firm, is shown only partially completed. This method is an inexpensive and yet very effective means of covering the conveyer and is applicable to any gallery conveyer. The drive of this conveyer is located at the head end and delivery is made into a chute serving the cupola charging cars similar to those receiving from the gravity discharge conveyer.

A conveyer independent of the other two is located in the basement of the foundry and delivers sand, coke, and broken stone from the track hopper into several of the storage bins. This is also an 18-inch belt conveyer, 50 feet between centres, driven at the tail end from a five-horse power motor suspended from the ceiling. This motor also drives the 24-inch, 13-foot, apron feeder, which is located on the other side of the basement wall beneath a 12-foot track hopper. At the head end of the conveyer is located a rotary cleaning brush, which cleans the return belt, removing the fine sand and the coke dust, preventing their accumulation on the return carriers and preventing the different materials carried from becoming mixed one with the other. This cleaning brush is a standard arrangement and is always located at the head end of the conveyer directly back of the head pulley, and is driven from a sprocket on the head shaft. The mechanism is self-contained and dust-proof and may be applied to any size brush and any size of conveyer. A web sprocket is used cast integral with an internal gear which meshes with a pinion on the brush shaft. An adjustable weighted lever arm provides the proper tension for the brush against the belt and automatically takes up the slack as the brush wears down.

This conveying system, consisting of four conveyers, was manufactured by the Stephens-Adamson Mfg. Co., to meet the special requirements of the Massey-Harris Company, Limited. The entire equipment was designed by Mr. Edwin J. Banfield, 120 Adelaide St., West, Toronto, Ontario, who is a special representative of the Stephens-Adamson Mfg. Co. in Ontario.

THE NEW CANADIAN PACIFIC RAILWAY SHOPS AT OGDEN, ALBERTA.

The main locomotive shop building contains the erecting shop, machine shop, blacksmith shop and boiler shop. The erecting shop will be of the transverse lift-over type, and will contain 35 bays of 22 feet each. Its entire area is served by travelling electric cranes carried on two levels. It is of structural steel frame on concrete foundations. The exterior walls up to window sills are of concrete, and the walls which are carried on steel members of hollow tile plastered. It is heated by indirect fan system distributed by concrete and tile ducts.

The department for making repairs to locomotive tenders, steam shovels, lidgerwoods and other maintenance-of-way equipment, is contained in an L-shaped building, 80 x 340 feet, and is equipped with a high-speed 20-ton travelling crane having two 10-ton trolleys. There will be a depressed track carried along the end of the wheel storage tracks outside, to facilitate unloading and loading wheels and axles. The building is of structural steel frame with steel roof and trusses and its general construction will be similar to the main locomotive shop.

The storehouse and office building is 250 x 60 feet, two stories, with offices at one end three stories high. It contains an electric elevator, vaults and platform scales. It will be parallel with the main building, the space between to be spanned by a high-speed travelling crane, which will handle all material to and from the cars and from the storage place that is provided between the storehouse and the erecting shop. The concrete foundation is carried up to bring the floor of the storeroom to car door height, and the walls above are brick and concrete blocks, supported on concrete foundation walls, the woodwork of heavy timber comprising slow burning mill construction. The building is heated by an indirect fan system, and sprinklers are installed for fire protection.

The oil house, 102 x 40 feet, is similar in construction to the storehouse.

The foundry is 204 x 80 feet, of similar construction to the main building, having two bays, one of these of higher cross section to be served its entire length with high speed travelling electric crane. Jib cranes attached to building columns are provided and so arranged that they may be moved from one location to the other if desired, handled by the travelling crane. In the side bay of lower cross section is provided for core making and snap moulding floor. The charging floors and cupola will be located in the centre of the low bay. The heating is indirect fan system distributing

through galvanized iron pipes carried overhead. Steam, air and water service, including fire protection and drinking water are provided. The location of this building alongside yard crane will enable the unloading of scrap and pig-iron to be taken care of by the crane. This close proximity of the foundry to the crane will also reduce to the minimum the handling of the castings from the foundry to storage or to the main shop or loading for shipment.

The pattern shop, 100 x 30 feet, for pattern storage and pattern making will be of similar construction to storehouse.

The coach repair and paint shops are contained in one building, 362 x 146 feet, having 15 tracks at 24 feet centres. It is of slow burning mill construction having concrete block or hollow tile walls on concrete foundation. It is heated with the indirect fan system distributed underground in concrete and tile ducts, and protected from fire by automatic sprinklers.

Transfer table and pits. For serving the coach shop there will be installed a 75 ft. transfer table of 150 tons capacity, equipped with an electric motor. The transfer pit and track foundations are constructed of concrete. This pit will extend far enough at either end of the building to provide entrance and egress at both ends.

The freight car repair shop, 300 x 231 feet, is designed to contain eight repair tracks placed in pairs giving room for an industrial material track between each pair of tracks. A brick wall partitions off a wall 50 feet wide along one side which contains the blacksmith's forges, wood working and machine tools, the heating plant and foreman's office. The locaton of this building alongside of the lumber yard will permit of handling lumber so that it can be passed through into the shop without rehandling. An overhead trolley beam will be erected to permit of handling timbers with a trolley into the shop. Material bins will be located convenient to the building for storing material used on the cars repaired in the shop. The building is constructed with walls supported of concrete foundations having steel posts supporting steel trusses. The roof is of saw toothed construction to permit of good light during the day. The general construction of the building otherwise is the same as that described for the other buildings, including fire sprinklers and indirect fan system for heating.

Yard crane. The entire area, about 80 feet wide between the storehouse and locomotive shop, will be served by a high speed travelling crane of 10-ton capacity. The runway for this crane will extend for more than 1,200 feet, passing down alongside of the foundry and covering the space occupied by the scrap dock. One of the storehouse tracks extends through under this crane, giving ample space for the storage of heavy material alongside of the storehouse, foundry, and locomotive shop. By this arrangement heavy material will be unloaded, stored and rehandled to the shop or loaded out again for shipment by the crane practically eliminating manual labor in the handling of heavy material.

The power house, 104 x 84 feet, will have sufficient space for boiler equipment necessary to provide steam for heating the shops and for such other purposes as steam will be required throughout the shops. The building will have brick walls carried on concrete foundations with steel roof trusses and supports for coal bunkers. The chimney is of reinforced concrete. Overhead bunkers for coal are provided and concrete dumping pit for unloading coal. An overhead storage bin for shavings will also be provided and another storage bin for cinders from which bin they can be discharged by gravity into cars alongside of the building.

The planing mill, 300 x 80 feet, will contain the woodworking machinery having a track extending through longitudinally to permit of movement of material to the various machines with the minimum amount of handling. The building will be located so as to be convenient to the coach shop and freight car shop. The lumber yard will be located back of and at one end of the planing mill. The building is of hollow concrete blocks carried on concrete foundations with steel roof trusses covered with 4-inch plank sheathing. The heating is by the indirect fan system. Provision has also been made for lavatories, metal lockers and suitable piping for distributing compressed air and water, including fire protection and drinking water.

The mess building is about 150 x 30 feet, of one story, except a portion of the centre which will be carried up two stories. Miscellaneous buildings. Inclnded in the scheme are dry kiln scrap docks, material bins, plate and iron racks, and other buildings in the yard.

CEDAR RAPIDS POWER AND MANUFACTURING COMPANY.

Arrangements in connection with the financing of Cedar Rapids Power and Manufacturing Company have been completed and a circular issued to Montreal Power and Shawinigan shareholders, announcing the subscription terms. There has been no change in the plan originally announced. Montreal Power and Shawinigan shareholders are to be given the right to subscribe to an issue of about $8,500,000 five per cent. bonds of the Cedar Company, in the proportion of 30 per cent. of their respective holdings. The bonds, as first announced, will be issued at 90, with a bonus of 25 per cent. common stock. If the bonds hold around the issue price, and the Cedar Rapids stock sells at 60, subscription privileges would be worth about $5 on each share of Montreal Power and Shawinigan stock. Cedar Rapids stock sold the other day at 70 in private transactions.

The circular states that out of the first instalment of 120,000 horse-power, 60,000 horse-power has already been sold to the Aluminum Company of America and 20,000 to the Montreal Light, Heat and Power Company, and that the profits from this will provide for the operating expenses of the company, the interest on the issue of $8,400,000 bonds now offered, and leave a substantial surpius against the common stock of the company. These earnings will be greatly increased by the sale of the 40,000 horse-power remaining from the first installation as well as from the power to be developed in the second installation. This latter amount will be from 40,000 horse-power to 50,000 horse-power, and according to one statement should provide a profit of about $20 per horse-power.

Of the above bonds and stock the shareholders of the companies would divide as follows:—

	Bonds.	Stock.
Montreal Light, Heat and Power Company	$5,100,000	$1,275,000
Shawinigan Water and Power Company	3,300,000	825,000
	$8,400,000	$2,100,000

RAILROAD EARNINGS.

The following are the railroad earnings for the week ended January 7th:—

	1913.	1912.	Increase or decrease.
Canadian Pacific	$2,140,000	$1,602,000	+ $538,000
Grand Trunk	850,889	735,888	+ 115,001
Canadian Northern	341,500	289,200	+ 52,300
Temiskaming & Northern Ontario	26,561	26,622	— 61

POWER PRODUCTION IN NORTHERN ONTARIO

Steam power has been almost wholly displaced by hydraulic power delivered either by the electric current or in the form of compressed air, for the operation of Cobalt mines and works. Most of the mines formerly using steam retain their plants for use in case of emergency, but the regular employment of steam is now confined to small and isolated properties.

An amalgamation between the companies producing power on the Montreal River has been effected, the Cobalt Power Company and the Cobalt Hydraulic Power Company uniting to form the Northern Ontario Light and Power Company, Limited. This arrangement enables the plant at Hound chute to confine its supply to electrical energy only, while the Taylor compressed air system installed at Ragged chute fills the contracts for compressed air.

Mines Power, Limited, whose development on the Matabitchewan was first in point of time to put electric power into Cobalt, has changed its name to the British Canadian Power Company, Limited.

On both the Montreal and Matabitchewan Rivers, though the shortage of water was not so marked during the winter of 1911-12 as it was in the previous year, experience has shown the present means of conserving the freshet flows to be insufficient for the steady delivery all the year round of the maximum quantity of power.

The watersheds of the Matabitchewan and the Montreal have both their peculiarities. The former is not extensive, being restricted on the north by that of the Montreal, and being still further narrowed by the tendency of the river to approach the Montreal as it nears its mouth, the actual entrance of the two rivers into Lake Temiskaming being only a few yards apart.

For this reason, strict economy must be practised in the use of water, and the company has found it necessary, in addition to the reservoirs already in existence, to erect dams at the outlet of Bear, Cross and Macdonald Lakes. When these are completed, practically all the natural storage grounds on the stream will be under control.

The Montreal is a longer and larger river than the Matabitchewan, but the area which it drains is lessened by the doubling, tortuous course which it pursues, especially in its southern branches.

It receives a portion of the overflow of Lake Temagami through the northern outlet of that lake, the main discharge of which is to the south by the Temagami River, a feeder of the Sturgeon.

Being thus situated on the height of land, the waters of this large and important lake, if conserved, are capable of considerably augmenting the water power of either or both the streams into which it empties. It is also evident that by adjusting the height of the dams at the northern and southern outlets, a larger or smaller proportion of the total discharge from the lake could at will be diverted into either system.

There are important hydraulic developments on both streams, on the former for power used mainly in the mines of Cobalt, and on the latter for the operation of pulp and paper mills at the town of Sturgeon Falls, reports Mr. T. W. Gibson, Deputy Minister of Mines, in the 21st annual report of Ontario's Bureau of Mines.

This situation is indicative of the classes of questions to which the rapidly increasing use of water power derived from the rivers of Northern Ontario is giving rise. But there is yet another, and very important, element in the situation.

For many years, these rivers have been used by lumbermen to float their logs to market, and their right to employ them for such purposes has been repeatedly confirmed by the legislature of the province.

Indeed, notwithstanding the extension of railways into the northern forests, and the increasing use which is made of them to transport logs, pulp-wood and other forest products to the place of consumption or manufacture, it is not easy to see how the great lumbering industry of Ontario could be carried on without the free use of these waterways.

There is nothing incompatible between the employment of flowing water for the carriage of sawlogs and its utilization for the development of power. But it is quite apparent that the presence of two distinct interests, each requiring the use of water, but for a different purpose, is likely to be productive of friction.

When the spring thaws and rains melt the snow and ice, and let loose the floods, the lumberman seizes the opportunity to get his "drive" to market. His logs in the water, he lifts the "stop-logs" from the dams and gives rein to the torrent that it may hurry his logs to their destination. Every consideration must yield to this—the logs must come down, for to be "hung up" means in most cases that another year will elapse before the logs will reach the saws, and also a loss in interest and the sinking of water-logged timber. The main body past, the rear-guard of his army "sweeps" the "tail of the drive," in other words, gathers up those logs which have stranded in shallow places, or have been caught by the rocks or other obstructions.

This demands a fresh draught on the dammed-up lakes, in order to carry the "tail" down stream, and the freshet season may well be past, or nearly so, before the lumbermen's use of the river is over for the time.

It is obvious that the owner of a water power on such a stream will find it difficult to obtain a maximum of power. The water is hurried away, which might have turned his turbines during the dry season, and his chances of equalizing the flow to the best advantage are correspondingly reduced. The situation is one which suitable legislation may be required to meet.

Much may be accomplished by co-operation between water power owners and lumbermen, by improved log-slides requiring a minimum of water to operate them, by deepening river channels, and removing obstructions, etc., but it may also be necessary to provide some means of adjusting the relations between the lumbermen and water power owners, so far as the use of the water is concerned, and also between the various users of power on the same stream, whose interests may conceivably come at times into conflict.

INDUSTRIAL ACCIDENTS.

According to the record of industrial accidents maintained by the Department of Labor, 97 workmen were killed and 357 injured during the month of December, 1912, as compared with 114 killed and 359 injured during the month of November. The greatest number of fatal accidents occurred in steam railway service, building trades and navigation, the figures being respectively 20, 17, and 12. The largest number of non-fatal accidents occurred in steam railway service, there being 131 employees injured, followed by the metal trades with 75 injured. The disasters of the month involving the death of more than one workman were a mountain snow slide at Fernie, B.C., by which six employees of a coal mine were killed and eight injured; an explosion in a pulp mill at Grand Mere, Que., by which four men were killed; and the drowning of four sailors off Yarmouth, N.S., during a storm.

THE EPIDEMIC OF TYPHOID FEVER IN THE CITY OF OTTAWA.*

By Charles N. B. Camoc, B.A., M.D.

In the city of Ottawa there have occurred two outbreaks of typhoid fever within eighteen months. This is so unusual an occurrence in our present knowledge of hygiene and sanitary engineering that it is no longer of local interest merely, but attracts the attention of physicians and sanitary engineers the world over. Besides sharing with the medical profession this general interest, my attention was specifically directed to the epidemics by being consulted by several citizens of Ottawa regarding the safety of residing in that city during the coming year.

Through the courtesy of some of the government authorities I was enabled to acquaint myself with the conditions leading up to the outbreak. As the whole matter is under investigation, to be reported upon later, I will not attempt here to deal with these conditions in detail, but will state some general facts regarding the dangers, to the community at large, which such epidemics occasion.

Typhoid is a preventable disease—its cause and mode of transmission are among the best known to the science of medicine; where the measures for prevention have been intelligently and conscientiously carried out, typhoid fever, in epidemic form, does not appear.

Transmission of Typhoid by Individuals.—The germ is carried and transmitted by individuals in the following ways:

(1) By those who have sufficient resistance to entirely neutralize the poisons and who are therefore not ill. Such individuals (immunes), though they discharge the organism in virulent form, show no other sign of the disease.

(2) By those who have only enough resistance to partially neutralize the organism, and who are, therefore, partially disabled. Such individuals (walking cases) discharge the organism in virulent form and the sequels of the disease may develop in as severe a degree as in typical cases.

(3) By those who have passed through a typical attack and have recovered. These and the walking cases may harbor the organisms for months or years. Such individuals (typhoid carriers) discharge the germ, in full virulence, from time to time.

FORMS OF THE DISEASE.

The disease appears in two forms::

1. The Sporadic Form.—This is usually traceable to some source outside of the locality in which the disease appears. For example, people returning from travel or from a summer resort, may bring in their systems an infection which runs its course and is not found beyond that particular group of persons. The Fests in Germany and the fairs and exhibitions in other countries are frequently the means of receiving and transmitting such an infection. This is also true of soldiers returning from campaigns. It will probably be a long time, and then possibly only through vaccination, before such outbreaks can be prevented. In all outbreaks it is possible for carelessness on the part of those in attendance upon the sick to extend the infection to themselves and others. This occurs through every point of contact between the fecal and urinary discharges of the typhoid patient and the alimentary tract of the uninfected individual. Such transmission is the fault of the physicians, nurses and attendants and is exclusively chargeable to them. These outbreaks, claiming their complications, sequels and mortality with the same exactness as the largest ones, are none the less tragic, but public opinion is not, as a rule, aroused.

* Issued by the Commission of Conservation, Ottawa.

Of late years the medical profession, without the goad of public opinion, has diligently striven to prevent such, and has incorporated into every medical and nursing school the training which will enable physician and nurse to safeguard the community against such transmission.

2. Epidemic Form.—Under this head comes the Ottawa visitation. It is hardly necessary to mention the less common causes of such an epidemic or to describe its features. The two outbreaks through which Ottawa has passed were caused by the commonest and best understood of all the causes of disease—namely, the contamination of drinking water by sewage. In other words, that which is scrupulously avoided in the care of the typhoid case, was, by the contamination of the Ottawa water supply, brought about in the grossest possible way.

While nurses were disinfecting discharges and sterilizing the utensils of those known to have typhoid, thousands of other persons, harboring the germ in one or the other of the ways referred to above, were transmitting organisms through the foul water directly into the alimentary tract of innocent victims.

Ottawa is outwardly a beautiful city. It is the seat of the government of Canada, a country rapidly striding into international prominence. Her people, by ever-increasing railway and steamship systems, are traveling, not only through Canada, but also through the United States and other countries.

From the modes of harboring the organisms given above, it will be seen that during and after such epidemics as Ottawa has had, every individual from the seat of outbreak may be a menace, not only to his own community and country, but to any which he may visit. The typhoid epidemic to-day is an unpardonable crime against the world. It is scientifically punishable under the sixth commandment. By scientifically is meant that science has proven that typhoid epidemics are preventable by well known and thoroughly tested methods, which, if not adopted, render the authorities guilty of murder. The command to adopt such measures should be coupled with the charge, "Thou shalt not kill."

Prevention of Typhoid.—In no other disease has science so clearly and so simply pointed out the methods of prevention. The stage of experiment in this matter has long passed.

Smallpox, yellow fever, cholera and typhus, from being a constant menace to society have become, through the work of science and sanitary engineering, almost unknown.

Tuberculosis, in spite of the persistent ignorance of some communities, is, in its severer forms unknown, and from being looked upon as an inevitably hopeless disease is now among the almost certainly curable. Diphtheria and malaria also must be mentioned in this list of curable and preventable diseases. To acquire these results, the highest type of scientific acumen, the sacrifice of life, the expenditure of enormous sums of money, and legislation, municipal, national and international, have been necessary.

To prevent typhoid, on the other hand, two things only are necessary—two things long recognized as essential to the health of any community—pure water and proper drainage. The official report shows that the Ottawa epidemics, claiming their hundred and fifty-six deaths, were due to the failure to supply these requirements. To this list of the dead must be added those who will suffer from many sequels now known to be directly due to the typhoid organisms, some being incapacitated for years with consequent poverty and suffering, the full story of which will never be known.

To this also must be added that host of victims stricken down by the typhoid carriers and walking cases, emerging from such an epidemic. These latter can transport the germ

in its full virulence to any part of the world, thus connecting the negligence or ignorance of the municipal authorities in one locality with the hideous tragedies of a typhoid outbreak in another, far removed from the original source of infection

Necessity of Federal Regulation.—It costs the government of the United States $18,000 to complete the education of an officer for the navy. After the most thorough and searching examination, the candidates are selected to serve in maintaining the nation and protecting commerce. The same is true to a large extent of the army. Why should an army and a navy be maintained against possible destruction to empire or commerce while a national menace to life is met by partially prepared or ignorant local authorities? Why should not the maintenance of a National Health Department, equipped with men prepared with the care given to the education of the navy or army officer be considered obligatory? No such national safeguard exists, except in quarantine stations. There is, as it were, a Foreign Office but no Home Office or Department of the Interior for health matters.

Our present system is analagous to despatching a body of city police to meet an invading army or to attack an enemy who had seized some important town. In a military sense the idea is ridiculous, yet this is exactly what is done in coping with a national enemy like typhoid fever. At present, in Canada and the United States, it is not possible for an expert with the authority of the Federal Government to compel a small city whose water and drainage system may be a source of national danger, to correct this condition. That the Ottawa authorities did not realize the far-reaching power of their epidemics, is shown by the fact that they permitted their plan for the annual exhibition, held at Ottawa, to be carried out, drawing thousands to that city, at a time when new cases of typhoid were still being reported.

I am told that the experience through which Ottawa has just passed could be repeated at Montreal; that the relation of water supply to sewage is such that a contamination as it occurred at Ottawa might take place at any time at Montreal. If the National Government were responsible for the water supply and sewage, as it is for quarantine stations, coast defences, light houses and harbors, it would be possible to institute uniform measures approved by the highest authorities. Until some such plan is adopted, this question of vital importance will be at the mercy of political manipulation and the ignorance of half-trained officials.

As stated at the beginning of this article, these opinions are expressed with regard to typhoid fever in general. I do not wish to convey the impression, that what has been witnessed in the state of affairs prevalent in Ottawa is peculiar to that city; the menace lurks, under our present health regulations, in many large towns throughout the continent. The grave-yards of Philadelphia and Baltimore are filled with the silent victims of municipal ignorance or political corruption. What, I trust, has been shown is that a typhoid fever outbreak of the proportion of that in Ottawa, is a subject for widespread concern. It calls for the most serious consideration of the present health regulations, which make possible so appalling a destruction of life and health in an otherwise fair city.

Is it possible to allow longer so subtle and hideous a national enemy to be met only by local health officers whose training may be inferior and whose appointment may have been the price of some political favor? Why cannot our health officers, like our military and naval officers, be removed from petty political influences? Why should not this continent benefit in its maintenance of health by the highest scientific ability? Why should commerce receive more adequate protection than public health? Finally, Ottawa's epidemics, and all outbreaks of like proportion, must remain in their consequences a national and international menace for years to come.

NEW BRUNSWICK'S LUMBER INDUSTRY

The opening weeks of the new year have brought indications of a progressive movement for 1913 The managing director of the Atlantic Sugar Refineries, Limited, visited St. John with other officers of the company to arrange for immediate work on the foundation of the sugar refinery The foundation work will be done by an American concern. There will be a group of seven buildings.

The announcement is made that the plans of the Grand Falls Company for the development of electrical power on a large scale, and the erection of a large pulp mill at Grand Falls, are being prepared.

At Taylor Village, near Dorchester, a crew of men are at work prospecting for manganese, and the indications are favorable.

A landscape architect has arrived at St. John from Montreal to plan a model workingman's village for the employees of the Maritime Motor Car Company, three miles from the city.

The St. John Valley Railway Company have given orders for a sufficient quantity of 80-pound rails to lay 120 miles between Gagetown and Centreville, passing through the city of Fredericton. These rails are to be delivered in June and July, and it is expected that this portion of the line will be nearly finished this year.

The Canadian Pacific Railway Company will increase its accommodation for cars on its property at the head of St. John Harbor, where last year it laid extensive tracks and built warehouses.

A member of a large lumber concern in Boston was in the city last week placing orders, and states that he expects to buy 12,000,000 feet of New Brunswick lumber. Speaking for the lumber interests of the United States, he said they did not look for any change in the lumber tariff and did not want any.

There have been notable increases in the last year in the quantity of spruce shipped from Northern New Brunswick to Montreal, and a number of cities in Ontario, Toronto included. This market has been of great value at a time when ocean freights for lumber were practically prohibitive.

The present winter has been almost the mildest on record, and quite the worst for lumbering operations in the history of the trade. There has been more water in the swamps, and the absence of snow has greatly impeded work, and the cut of logs will, therefore, be very much smaller than usual.

The Dominion Coal Company made plans last year for the extension of their plant for handling coal at St. John. It is stated that this work will be carried out this year.

Norton Griffiths Company, Limited, are asking some financial concessions from the city and province with a view to making the new drydock 1,150 feet long instead of 900 feet, and offer in return to reclaim a site for steel works and shipbuilding plant, and to bring about the establishment of these industries.

AT NIAGARA FALLS.

The year 1912 was a good one at Niagara Falls, Ont. Possibly $300,000 worth of residential building and fully $600,000 of factory buildings, mostly additions to present factories, were erected. Six new industries were located there during the year, and prospects for 1913 are exceptionally bright. In addition, the three great power development companies operating there have expended many millions in increasing their plants.

The Excelsior Brick Company has increased the amount of its capital stock from $150,000 to $250,000, such increase consisting of 1,000 shares of new stock of $100 each.

A MODERN STEEL MILL BUILDING.

One of the largest and most up to date mill buildings in Northern New York was built this season for the Bagley and Sewall Company, of Watertown. This firm is one of the foremost manufacturers of paper making machinery in the world, and their business has increased so rapidly that very frequent additions to the plant have been necessary.

In a recent issue of the Cornell Civil Engineer, Mr. A. W. Harrington, has an article describing the construction of this building. The following is abstracted from the article.

The structure in question is 420 feet x 120 feet in size with a small wing 120 feet x 30 feet. The frame is entirely of steel and the walls concrete, and plaster on Hy Rib. The main structure is carried by the outside 8 inch and 10 inch wall columns and by two rows of 20-inch columns running the length of the building and providing a crane run of 60 feet span, in which operates a Niles fifteen ton electric crane.

A mezzanine floor, for light machinery, 30 feet wide, runs down the north side and across the east end of the building. The south bay, also 30 feet wide, comprises a crane run for a Niles ten ton electric crane.

In the future, finished work can be loaded for shipment directly on the cars, two branch tracks entering the building from the west end, and being served by the 15-ton and 10-ton cranes respectively.

Excavation for the boiler room and coal pocket was begun in January, and some 2,000 yards of rock were taken out and crushed for use on the work. The first concrete was put in the walls of the coal pocket early in March while the weather was still cold. To prevent freezing the water was heated and 5 per cent. of salt added, it not being entirely convenient to heat the sand and crushed stone.

The foundations for the side walls and the piers for the centre columns were next put in. The footings for the side walls were 20 inches wide on top and varied in depth from two to twenty feet, being carried to rock in all cases. The centre piers were 30 inches square. The base plates of all columns were drilled for two anchor bolts, and these bolts were put in when the walls and piers were built. The forms were strongly braced to line and the tops cut off to the floor level and then wooden templets were set to hold the anchor bolts in place while concreting was progressing. It was necessary to locate the anchor bolts very carefully, owing to the large number of columns and the very considerable length of the building, for this purpose a straight edge, or templet was made, in each end of which were two holes, to correspond to the two bolts, and the distance between the two pairs of holes was laid off very carefully. The templets on the forms were laid off with this straight edge and lined in with a transit. In this way the anchor bolts were spaced correctly and uniformly, which might not under all conditions be possible with a steel tape.

As fast as the steel arrived, it was unloaded directly from the cars with a small derrick, and as soon as sufficient steel was on the ground, erection was begun at the east end. A traveler with an 85 foot boom was used, and it was possible with this equipment to reach the entire width of the building and put up the full section of the work at once.

The cost of erection of the 600 odd tons of steel ran about $8.00 per ton. A small air compressor, supplied with steam from the hoisting engine, delivered air for two riveting hammers. Two gangs drove on an average about 275 rivets each per day, and the 12,000 or more rivets cost in place around eleven cents each. The riveters were followed by the painter, and the contract price for this work was 60 cents per ton, a rather high figure for this class of work.

The Detroit Fenestra steel sash was attached directly to the steel window framing. Practically the whole elevation of the building on all four sides is steel sash, and in addition, a row of monitor sash on either side of the main roof furnished light from above.

The next step was the putting up of the Hy Rib for the walls. All walls above the sill of the lower windows were of plaster on this material. The Hy Rib was attached to the window framing and steel work by wire and the standard clips. The cost of the work was high, inasmuch as it was in such small detached pieces, owing to the closeness of the windows, etc.

The plaster on the Hy Rib was about a two to one mixture, and the finished wall was generally about 2½ inches thick. The labor cost of putting this on figured about $1.00 per square yard, exclusive of material. This sort of thing for outside walls is something new in this part of the state, where the winters are very severe, and it is somewhat of a question how this thin wall will compare with brick or concrete of ordinary section as a non-conductor.

Heavy ribbed glass was used on all windows, there being some 20,000 square feet of surface.

While this work was progressing the roofs were being put on, 3 inch x 6 inch nailing strips were fastened directly to the trusses and roof beams with lag screws, and a 2-inch southern pine roof laid on the strips. A Barrett Specification 5 ply roof was then put on. The roof water is carried by gutters to frequent down spouts, by which it is conducted into several drains which lead directly to the river.

Foundations for all the heavy machines were put in as soon as the frame was up. These were invariably of concrete and carried to rock.

The main floor consists of a 6 inch concrete base, with a 2-inch hardwood floor laid on 4-inch x 4-inch treated nailing strips embedded in the concrete.

The larger doors are all Kinnear rolling doors of suitable type.

The building is to be heated by steam furnished by one 200 H.P. and one 50 H.P. boiler. All power is electric, and is furnished from the company's power plant near by.

The cost of the building, exclusive of any equipment, was about $100,000. The work was done by force account, except the steel work and the heating. The structural steel was designed and erected by the National Structural Company of Syracuse.

TESTS OF ROOF BEAMS.

Physical and chemical tests have been made by Messrs. Robert W. Hunt and Company for the investigating committee of the City Council of one of the two collapsed I-beams in the roof of the Home Theatre building, Chicago, the failure of which was reported in the Engineering Record on December 21, page 682. A 4 x 20-in. specimen of steel was cut from the web of one of the ruptured 24-in. I-beams, 8 in. from one end and 3½ in. from the top of the flange. The specimen was machined into a standard-shaped test piece, the central 9-in. portion of which had cross-section dimensions of 1.535 x 0.474 in. After fracture this section was 1.141 x 0.307 in., giving 51.86 per cent. reduction in area. The elongation in 8 in. was 2.22 in., equivalent to 27.75 per cent., and the character of the fracture is described as silky. Under a 180-deg. cold flat-bend test the report states the specimen is "O.K." The elastic limit was 39,240 lb. per square inch and the tensile strength 59,180 lb. per square inch. Chemically, the analysis of the drillings is given in percentages as follows: Carbon by combustion, 0.098; phosphorus, 0.109; manganese, 0.49; sulphur, 0.126; silicon, 0.01.

MONTREAL TRAMWAYS AND SUBSIDIARY COMPANIES

Matters in connection with the Montreal Tramways and Power Company and its subsidiaries are occupying almost the entire attention of financial circles in Montreal and the citizens generally. The Monetary Times last week reviewed the case of Messrs. Ernest E. Vipond and Herbert S. Vipond against the Corporation Agencies, Limited, and H. A. Lovett, K.C. Plaintiffs were suing for $279,500 which they claimed was the value of the rights and franchises of the Montreal Hydro-Electric Company, which had been turned over to the Montreal Tramways and Power Company by defendant, the Montreal Hydro-Electric Company being a holding company or merger formed by Mr. Lovett of two concerns of which the Viponds were apparently the principal owners. They were the entire owners of the Montreal Electric and, they alleged, were the owners of an option on the other company, the Electric Power Company of Montreal, which, Mr. Lovett, in the direction of carrying out his contract to carry the scheme through to an operating basis, had merged into the Montreal Hydro-Electric. This was in 1911.

The Viponds claimed that defendants had not fulfilled their contract in the manner in which it was made but had turned the Hydro-Electric into the Montreal Tramways and Power which was the big concern formed to take in the Canadian Light and Power, the Tramways Company and a number of other smaller power concerns of the city. Their particular objection seemed to be to the inclusion of the Canadian Light and Power in the Tramways and Power Company.

In this connection, came up the name of the Imperial Trust Company, which had officiated in the transfer of the Hydro-Electric to the Tramways and Power Company. It was shown that it was under the same control as the Canadian Light and Power, the Tramways Company, and the Tramways and Power Company. Further connection was attempted by showing that Mr. H. A. Lovett, K.C., was closely associated with this group of companies also, as their counsel. Then was made an attempt to have certain documents relating to the deal produced by the Imperial Trust Company. Argument on this point went on for some hours and resulted in the Judge ordering the production of the documents. The official claimed he would have to consult those in authority first, upon which the Judge read him a lecture and ordered the documents to be produced.

At this juncture the counsel for the defence announced that under such circumstances he would beg to take the matter to the Court of Appeal. The matter will accordingly be brought before the Appeal next month.

Meantime, the Canadian Light and Power Company has sustained an attack from another direction, certain large contractors having entered suits for amounts aggregating, it is claimed, nearly half a million, on the grounds that contracts completed at the company's plant near Valleyfield had never been paid for and that their engineers had been prevented from making the final estimates necessary to secure the balance of payments due

During the past week, also, the appeal of the Tramways Company on the grounds of jurisdiction was made against the Public Utilities Commission of the province of Quebec. The arguments put forward were much the same as those outlined at Quebec recently, when the company was ordered to appear and show grounds why the Commission should not take other means to obtain the details of information previously ordered, and at the expense of the company. The burden of the appeal was that the government of the province had relieved the company of the jurisdiction of the control of the Commission. The lawyers who were to present the arguments to the contrary were not ready, so that the matter will be heard later.

OUR PIG IRON MADE FROM NEWFOUNDLAND ORE

Some interesting evidence concerning the demand for and supply of iron ore was given before a meeting of the Dominion Royal Commission held in England last year, by Mr. Wallace Thorneycroft. It was stated that most of the ore imported into Great Britain was made into Bessemer hematite pig-iron, which was used for steel making by the acid process. For that purpose the ore must contain very little phosphorus. Great Britain imported in the year 1909, 6,326,000 tons of iron ore, of which nearly 6,000,000 tons was Bessemer ore.

Nearly 5,000,000 tons of this Bessemer ore came from Spain, and the balance from Sweden, Norway, Greece, France, Algeria and Tunis. Except 62,000 tons from Newfoundland, no ore was imported during that period from the Dominions. Cumberland and North Lancashire supplied 1,558,000 tons of Bessemer ore. Therefore the Bessemer pig-iron industry depended upon foreign ore supplies.

It was probable that the deposits of Bessemer ore in Spain would be approaching exhaustion 25 years hence. It was also probable that supplies of this quality of ore would be got from other countries, but at an increased cost of freight. There were large known deposits in Brazil, Cuba, Chili and Venezuela, some of which were being developed.

The Wabana deposit in Newfoundland, from which the bulk of Canada's production of pig-iron was made, was said to contain over 3,000 million tons of ore. But as it contained .75 of phosphorus it was unsuitable for the manufacture of steel by the acid process. It was largely exported to Germany and Belgium, where steel was manufactured by the basic process, by which the phosphorus was extracted from the steel.

Basic steel, it was stated, was not as reliable as steel, manufactured by the acid process from Bessemer ore containing less than 0.5 of phosphorus. If the basic principle were adopted in this country there would be a greater demand for Newfoundland ore. The more rapid growth of the pig-iron industry in Germany and the United States was, it was said, entirely due to the invention of the basic process.

Except in Canada there was, so far as is known, no production of pig-iron on a large scale in the Dominions. The governments of the Dominions, it was stated, might, with advantage, provide more money for the geological survey of the territory under their control. There could be no more profitable investment. They should publish the results of the surveys made as rapidly as possible, and communicate advance copies to the iron and steel associations of this country, or abstracts and references to such publications.

It was not suggested that the governments should undertake detailed prospecting work. The geological department of Canada was already very good, but with the vast area it had to cover, progress was necessarily slow.

The indication of large deposits, especially Bessemer ore, accessible for shipment anywhere in eastern Canada or Newfoundland would promptly be investigated in detail by British makers of iron and steel and ample capital would soon be found if the deposits warranted development.

It would be right for the Dominion governments to encourage the export of iron ore. If the economic conditions around the deposits were favorable, production of pig iron and steel would naturally follow.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

"Structural Details of Hip and Valley Rafters." By Carlton Thomas Bishop, C.E., assistant professor of civil engineering, Sheffield Scientific School of Yale University, formerly draftsman for the American Bridge Co., and chief draftsman for the Hay Foundry and Iron Works. Published by John Wiley and Sons, New York; Canadian agents, Renouf and Co., Montreal. Oblong, quarto, fully illustrated by general drawings and typical problems; v. + 72 pages. Cloth; $1.75 net (7/6 net).

Reviewed by J. Roy Cockburn, B.A.Sc.*

This book presents the subject of hip and valley construction very clearly and in a very convenient form for reference. It is evidently intended more as a handbook for structural draftsmen than as a text book for students although it should serve admirably as either.

All notes are conveniently arranged and completely illustrated by general drawings and typical problems. The complete derivation of every complicated formula is given in full and can easily be followed by anyone familiar with structural detail, plane trigonometry and the elements of descriptive geometry.

The book is devoted almost entirely to the solution of problems relating to the connections of purlines to hip and valley rafters. Both flange and web connections are taken up and examples worked out for buildings intersecting at various angles. The graphical as well as the analytical solutions being given for the various cases.

Although the book is well written and accurate in nearly every detail there are a few points which are open to criticism namely, in fig. 1. on page 1, the term "elevation" is used to describe a view which is of the nature of a perspective. On pages 8, 10, 30, and 32 we find

formula (30) $\tan. C = \dfrac{b' \sin. L}{b'' + b' \cos. L}$ when L is less than 90°

and formula (31) $\tan. C = \dfrac{b' \sin. L}{b'' - b' \cos. L}$ when L is greater than 90°.

Formula (30) is correct for all values of L, the quantity (b' cos. L) becoming negative when cos. L becomes negative. Formula 31 is not only superfluous but wrong. Again on page 2 we read that all formulas have been arranged so that they involve the use of only three functions of any angle, namely, the sine cosine and tangent; which is quite desirable. We also learn from the notation given on page 3 that w' = the largest of the angles between the line of bend and the centre line of the top flange of the hip or valley rafter (steeper roof), and that z' = the tangent of the angle between the purline of the steeper roof and the hip or valley rafter in the plane of the roof. It should, therefore, follow that w″ and z″ would equal the tangents of the corresponding angles referring to the flatter roof, but in formula 26, pages 4 and 6, formula 67 pages, 26 and 28, and formula 73, pages 30 and 32, w″ and z″ are taken to represent the cotangents of these angles. The reason for such a change being given in a footnote which reads as follows:—

"If any of these values exceeds 1'—0″ the level should be reversed or the drawing so that the longer side becomes the 12″ base and the shorter side the reciprocal of the value found." This reciprocal is obtained directly from the cologarithm. Care should be taken, however, that the original values are used in all further calculations.

The book should prove of great service to all who are interested in the class of work which it treats.

*Lecturer in descriptive geometry, University of Toronto.

"Sewage Disposal in the United Kingdom." By Henry Lemmoin-Cannon, published by The St. Bride's Press, Limited, Fleet Street, E.C. Cloth; 8 x 5½ ins.; 320 pages, 52 cuts. Price $2.

Reviewed by T. Aird Murray.*

This treatise forms a compact text-book illustrating and explanatory of methods of sewage disposal as practised in Great Britain. The information as far as methods of sewage disposal are concerned, practically brings and leaves the reader in line with the conclusions and data produced in the fifth report of the Royal Commission. There is in brief much useful information of a legal and routine nature useful to the British engineer in preparing schemes which in accordance with British law must be submitted to and receive the sanction of the Local Government Board in London. This information concisely put should be of value to Canadian authorities in guiding and formulating regulations for the control of similar schemes here.

To the Canadian engineer the information to be obtained is more of historical than actual value, salient points which have awakened much interest on this side are not dealt with. We refer to problems of treatment of sedimented sludge by separator tanks. The engineer who is looking for

*Consulting engineer, 303 Lumsden Building, Toronto.

information on many of the more modern problems connected with sewage disposal will find the information very incomplete. On the other hand, the student who wishes to become familiar with the history of sewage disposal leading up from the older methods of land treatment to the more modern methods of biological treatment, will find crystallized in one volume a very large amount of useful information difficult to obtain so readily elsewhere. Perhaps the most disappointing feature in connection with recent English publications on sewage disposal is the monotony of sameness with which they are characterized. No sooner do we open a so-called up-to-date English publication on this question than we feel that we have seen the book before; page after page contain wholesale extracts from the almost out-of-date fifth report of the Royal Commission, and our eyes are met with the same old and familiar illustrative cuts gleaned from manufacturers' catalogues which are becoming familiar to Canadian engineers by the recent spread of catalogues throughout the Dominion. What we feel we would like to see on this side would be some concise work fearlessly written, disclosing and illustrating the many failures which must have accompanied the installation of so many varied types of sewage disposal systems in Great Britain. Such a work would be useful in a new country, so that past errors may be taken advantage of in designing new works.

"Modern Destructor Practice." By W. F. Goodrich. Published by Charles Griffin and Co., Exeter Street, Strand, London. Cloth, size 6 x 8¾ ins.; 278 pages, 116 illustrations. Price $4.

Reviewed by R. R. Knight.*

Well arranged, full of information, and replete with data of existing practice, this book commends itself to the municipal engineer.

The author leaves no doubt in the mind of the reader as to his conclusions which are clearly stated and well worth consideration. He discusses the type of furnace, and it is clear that the cellular type has had to give way to the continuous grate furnace. Shovel fed furnaces are advocated, while at the same time mechanical and top feed furnaces come in for consideration. It should be noted, however, that a mechanical feeding apparatus is being "tried out" now and any conclusion should be deferred until the results are known. Destructor engineers will generally agree with the author that the full load charge has proved a failure, and that some means of steady and intelligent feeding with some modification of the littered platform is required, either mechanical or otherwise.

In the chapter devoted to Refuse Destructors combined with Sewage Works, the question of power production only is treated with. The views of the author with data as to sludge burning would have been welcome.

The photographs showing proximity of dwellings, etc., to destructors are interesting, and have a value as arguments in many cases.

Under the title "Specifications," a lot of information is given, and should prove useful in providing a reasonable base for tendering. The author does not commit himself as to cavity walls. In the matter of cast iron skewbacks I can give hearty support. Water seals, the author considers undesirable. With this statement many will disagree. The water seal has proved itself an efficient, flexible joint invaluable where, as in the case of furnace castings and steelwork, there is so much warping and twisting.

Mechanical clinkering is mentioned. It is early yet, however, to make any definite statement regarding the efficiency of this adjunct.

*Main Drainage Department, city of Toronto.

The most important feature of this work is the author's views on the question of garbage reduction. Mr. Goodrich has done what a great many destructor advocates have done, and must do in the face of facts, viz., admit that reduction is established as a paying process and can be carried out in a sanitary manner.

The author, in spite of his previous condemnation of the process (mainly due to the operation of plants for gain) says "there are signs that reduction will be undertaken by municipal authorities to some considerable extent during the next few years. He adds that from personal observation (speaking of Columbus, Ohio), the works are free from those objections which have been the subject of continual complaint with regard to garbage reduction works generally. This admission is important coming as it does from such an eminent source.

"Steam Boilers." By E. M. Shealy, assistant professor of steam engineering, University of Wisconsin. Cloth, size 6 x 9 ins., 366 pages. MrGraw-Hill Book Co. Price $2.50 net.

Reviewed by R. W. Angus, B.A.Sc.*

This book forms the fourth volume of the series published for the Extension Division of the University of Wisconsin, and in the introduction the author states that it "was written primarily for correspondence students, and is intended for the use of firemen and others who may be in responsible charge of boiler rooms." Having this in mind formulas have only been introduced into the book to a limited extent and much descriptive matter has been inserted.

The first two chapters are devoted to a complete description and classification of various types of boilers in use, along with the setting in each case, and in most cases a brief discussion of the merits of the given type. The description is well illustrated and should be helpful in acquainting the reader with the great variety of boilers in use. One might naturally expect the chapter on stays, which is purely descriptive and explains the purpose, construction and use of stays, manholes, etc., to follow the general description, although no reasonable objection can be made to separating this from the other chapters by a few calculations.

The author has purposely avoided dealing with boiler design and yet has given some formulas, illustrated by numerical examples, which show how the thickness of the shell may be determined. Such calculations cannot help but be of assistance, and yet they are a little apt to be misleading unless the form of joint is discussed, as the latter is one of the leading factors in determining the thickness of the shell. The computation of the heating surface of a boiler, illustrated by a numerical example, worked out in a simple way, is of much value to the class of reader sought and the method employed should be very readily understood.

The next few chapters deal with the relation between heat and work and the effects of heat, and numerical illustrations are given in some cases. The work on the properties of steam, etc., is given in some detail to enable the reader to know the value of the various conditions of steam. This matter is at best rather difficult, but the writer seems to have treated it in as simple a form as possible and gives a table of the properties of saturated steam which may be made use of in solving problems.

While several pages have been devoted to factors of evaporation, etc., the boiler horsepower has been passed over in two paragraphs, which seems rather unfortunate, as it would give a very useful application of the steam tables, and after all the boiler horsepower is one of the primary ob-

*Professor of Mechanical Engineering, University of Toronto, Toronto.

jects of all tests and is very largely a measure of the value of the boiler. The author has devoted considerable space to this matter in a later chapter.

Some considerable attention has been given to fuels, their combustion and the methods of firing and of setting boilers, all of which are important.

The book further contains chapters on boiler accessories, chimneys and draft (in which the dimensions and construction of chimneys are studied), boiler feed waters, feed water heaters, inspection and care of boilers and on boiler testing. All of the chapters are well illustrated with cuts and contain some numerical examples.

On the whole the volume has been written with much care and gives a treatment of this subject that should appeal to a man with a sufficient technical knowledge to understand simple formulas.

"Design of Electrical Machinery." A treatise for the use, primarily, of students in electrical engineering courses. Vol. III., "Alternators, Synchronous Motors, Rotary Converters," by William T. Ryan, E.E., assistant professor of electrical engineering, the University of Minnesota. (Vols. I. and II. treat respectively of D.C. machinery and A.C. transformers). Published by John Wiley and Sons, New York; Canadian agents, Renouf Publishing Company, Montreal. Cloth. Price $1.50 net.

Reviewed by J. A. Johnston.*

The rapid increase in the mass of engineering knowledge, with its resulting demand for highly specialized engineers is fast creating the serious problem of how to present to the student within the available time, all of the fundamental information which he ought to have. Any work, therefore, which succeeds in concentrating into small compass the fundamentals of any particular branch of engineering is a step in advance in the solution of this problem. The volume above named is such a work. It presents in four well-ordered chapters, covering 122 pages, such fundamental principles and knowledge of the design of alternating current apparatus as should be possessed by every electrical engineering graduate. While the material presented is sufficient, with a pre-supposed knowledge of first principles, to enable operative designs to be made and is largely drawn from commercial designs, it makes no attempt, as is proper, to present all the kinks of commercial practice. The physical get up of the book is fully up to the standard of its publishers and leaves little to be desired. It is profusely illustrated.

"Modern Road Construction"—A Practical Treatise for the Use of Engineers, Students, Members of Local Authorities, etc. By Francis Wood, M. Inst. C.E., F.G.S., Borough Surveyor of Fulham, England. London: Charles Griffin & Co., Ltd. Cloth; 5¼ x 8 in.; 137 pages; two folding plates and 25 text figures. $1.50 net.

This volume, in a concise and not too technical form, gives the general characteristics and details of roads gathered from the author's experience in road construction. The book opens with a general introduction and a discussion of the effect of traffic on different types of roads, while the greater part of the remainder of the volume is devoted to bituminous construction.

This discussion is made up principally of notes taken by the author on road construction, repair and maintenance over quite a period of years, and as the notes are largely a result of his own practical experience and observation, the highway engineer will find them of considerable value. The author goes into considerable detail in describing bitumen and its application to road construction, not only as a blanket treatment, but also when incorporated in the road surface. Several pages are devoted to tests and analyses of bitumen and to comparisons of the results obtained by the use of different kinds of bitumens in road construction. A few pages are devoted to costs, but the cost data in the book can hardly be utilized by engineers in this country, as insufficient data are given of the rate paid per hour for labor and of the cost of material.

In the appendices are given typical specifications for constructing streets of macadam and wood pavement, and the specifications of the road board of England for surface tarring, and surfacing with pitch-grouted macadam, also extracts from the road board's specifications for tar and pitch. The book is well indexed, and is very clearly worded, making it interesting and very convenient for reference.

"Engineering of Shops and Factories." By Henry Grattan Tyrrell, C.E.; author of "Mill Buildings," "Concrete Bridges and Culverts," "History of Bridge Engineering," "Artistic Bridge Design," etc. New York: McGraw-Hill Book Co. Cloth, 6 x 9 ins., pp. xvii. + 399; 175 illustrations. $4 net.

Reviewed by C. R. Young, B.A.Sc.*

In this, his latest, book the author has gathered together a large amount of information of great value to those who have to do, in a responsible capacity, with the planning of shops, factories and industrial buildings of all classes. The subject matter is sufficiently comprehensive to interest at once the manager and the engineer, and yet possesses enough of definiteness and detail to be of considerable value to the engineer in a technical sense. Certain matters which have been treated fully in the author's "Mill Buildings" are briefly discussed in the present work but the larger part of the information presented is supplementary to that contained in the former book.

An examination of the contents reveals an opening chapter which will meet with the hearty approval of engineers and architects at least. It is a frank discussion of the various arrangements by which owners manage to secure plans, specifications and engineering services for the construction of their buildings. The fallacy of "free" engineering is exposed and a plea which ought to be convincing to any reasonable proprietor is made for the employment of expert engineers in accordance with the terms recommended by the great engineering societies.

Proceeding with his subject, the author lays down the principles governing the selection of a manufacturing site, and then discusses at somewhat greater length the "Economies of Factory Construction." Eleven different matters affecting the design of the plant, and on which the engineer should be thoroughly informed, are cited and discussed in order. Illustrative of preliminary designs and reports, the author inserts a report of his own covering the establishment of a proposed structural plant. Data affecting general design, such as æsthetic treatment, wind pressure, loads, stresses, specifications, then receive brief consideration, followed by a short chapter on the "Selection of Building Type." Material of considerable value to the engineer or architect then follows in a 63-page discussion of wood, metal and concrete framing. The production of a pleasing finish in concrete structures is given full attention in an excellent chapter on "Concrete Surface Finish." Then follow chap-

*Electrical Engineer, Ontario Power Company, Niagara Falls.

*Consulting engineer, 318 Continental Life Building, Toronto.

ters on "Costs of Buildings," "Foundations," "Ground Floors," "Upper Floors," "Walls, Partitions and Openings" "Roofs and Roofing," "Notes on Special Buildings," "Storage Pockets and Hoisting Towers," "Factory Heating," "Air Washing Systems," "Factory Lighting," "Drainage of Industrial Works," "Water Supply and Storage Tanks," "Steel Chimneys," "Fire Protection," "Cranes," "Yards and Transportation," "Estimating," "Construction," "Welfare Features," and "Standard Buildings." A useful bibliography of the subject of industrial plants is given at the end of the book.

The book is in every way a commendable addition to the literature of industrial plant design and should be in the hands of all those responsible for such work.

Fire Prevention and Fire Protection, as Applied to Building Construction. A handbook of Theory and practice. by Joseph Kendall Freitag, B.S., C.E. Published by John Wiley & Sons, New York, and Chapman & Hall, London. 1,038 pages; 4½ x 7 inches; 395 illustrations; Morocco, $4.00 net.

Reviewed by C. H. C. Wright.

This is a very timely handbook for the architectural profession and others interested in the text. It contains a very large amount of useful information sufficiently condensed as to be serviceable without being so brief as to leave the reader in doubt. The whole book is written in a descriptive manner which will make it interesting reading, and has been divided into six parts, viz.: I., Fire Prevention and Fire Protection; II., Fire Tests and Materials; III., Fire-Resisting Design; IV., Fire-Resisting Construction; V., Special Structures and Features, and VI., Auxiliary Equipment and Safeguards.

These parts have been further divided into chapters, each of which has been well studied with reference to the others, so that it is comparatively easy to find information on any matter connected with this broad subject. For example, Chapter III. of Part I. treats very thoroughly and clearly, as a handbook on this subject should, of "The Theory and Practice of Fire Insurance," and is of itself worth the price of the handbook. The chapter immediately following on "Slow-Burning or Mill Construction" is worthy of mention.

Chapter VII. in Part II., "The Materials of Fire-Resisting Construction," contains much useful information compiled as it is from a multitude of reports, laboratory tests, fire tests and conflagration tests, showing the behavior of many building materials. A few quotations which will show the attitude of the author might not be out of place here.

"No material with which we are at present acquainted, at least to any commercial extent, is fireproof." "The word 'fireproof' rather describes an ideal condition yet to be obtained." "Hence, in view of the misconception attached to the term 'fireproof' the word has been discarded for the more rational one 'fire-resisting.'"

"The efficiency of fire-resisting construction depends largely upon (1) The choice of materials; (2) The materials used for insulating or protecting those load-bearing members which, of necessity, are not fire-resisting; and (3) The limitation as far as may be possible of combustible finish or trim."

On the much debated question of structural terra-cotta or concrete, the author says (page 235): "No other materials employed in the fire-resisting construction have exhibited such seemingly contradictory testimony as to their fire-resisting qualities as have structural terra-cotta and concrete. Arguments and examples for or against tile and concrete could easily fill a volume of large size. If one has any preconceived bias in favor of either, it is not difficult to find, from recorded opinions and experiences, data sustaining such preferences." After some seventeen pages of condensed information the author concludes with the following (page 252): "The writer believes that there is no decided choice between good concrete and good structural terra-cotta construction."

Under the heading of "Permanency and Corrosion" is tabulated the information obtained from the delapidation of a number of buildings such at the Bank of the State of New York, built in 1855; the Mutual Life Building, San Francisco, 1893; the Gillender Building, New York, 1896, etc.

Among the opening remarks of Part II., on Fire-Resisting Design, is the following: "The question goes deeper than this, for the vital fire-resisting qualities must be inherent in the design, and cared for as naturally as are commercial aspects. A building intended to resist fire may be likened to a position intended to resist attack. The works to be defended must first be well chosen as to position, and substantially and scientifically designed; second, well carried out in all details at crucial points; and lastly, manned by an effective garrison or force."

The conclusions drawn from experience with regard to the many features in planning are very clear and forceful; e.g., no fire drill could be of assistance in a single loft building in New York City, and the only thing left for the occupants of any such building is to jump or be burned to death, as was the case at the Asch Building, (the Triangle Waist fire).

Much could be said of the following chapter on "Efficiency vs. Faulty Construction," as well as of many of those which follow, but space forbids anything more than to say that Part V. treats of the subject under the headings: Theatres, Schools, Residences, etc., and Part VI. of Sprinklers, Alarm Systems, Watchmen, etc.

The question of relative costs is fully dealt with in every case throughout the book and forms a most valuable feature of it.

This book will prove a great stimulus to the scientific and systematic study of fire prevention and fire protection.

"Canadian Almanac." Published by the Copp, Clark Company, Toronto. Cloth, 6 x 9 ins.; 520 pages.

This volume, brought out by the Copp, Clark Company, has been published continuously since 1848, and its usefulness increases each year. It contains, among other things, astronomical calculations, the complete customs tariff, a full list of Canadian post-offices, and information as to postal rates, militia list, names of all clergymen and lawyers, of members of the Dominion and Provincial Governments and chief officials, county and township officers, newspapers, educational institutions, Canadian amateur athletic records, and a splendid series of maps.

PUBLICATIONS RECEIVED.

"Forest Conditions of Nova Scotia." By B. E. Fernow. Published by permission of the Department of Crown Lands, Nova Scotia. Issued by The Commission of Conservation, James White, secretary, Ottawa.

U.S. Bureau of Mines. The second annual report of the Director of the Bureau of Mines to the Secretary of the Interior, for the fiscal year ended June 30th, 1912. Washington, D.C.

Report of the Forester for 1912. By Henry S. Graves, U.S. Department of Agriculture, Washington, D.C.

Principles of Drying Lumber at Atmospheric Pressures. —By Harry E. Tiemann. Being Bulletin No. 104, Forest Service, U.S. Department of Agriculture, Washington, D.C.

A General Summary of the Mineral Production of Canada. During the calendar year, 1911. Mines Branch, Department of Mines, Ottawa.

The Production of Coal and Coke in Canada. During the calendar year 1911. Mines Branch, Department of Mines, Ottawa.

Report of the Supervising City Engineer of the City of Vancouver, for the fiscal year of 1912. Mr. F. L. Fellowes, Supervising City Engineer, City Hall, Vancouver, B.C.

Economies in Railway Operation. By F. E. Wynne. Issued by The Canadian Westinghouse Co., Limited, Hamilton, Ont. A paper read before the Baltimore section of the American Institute of Electrical Engineers.

The Relation of Electrical Engineering to Other Professions. President's address by Gano Dunn. An address presented at the 29th annual convention of the American Institute of Electrical Engineers, and reprinted from the proceedings.

An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries. By L. P. Breckenridge and G. A. Goodenough. Being Bulletin No. 9, revised edition of the University of Illinois Engineering Experiment Station, Urbana, Ill.

Municipal Water Supplies of Colorado. Being Volume 12, No. 5, University of Colorado Bulletin, Boulder, Colo.

Organization of the Public Service of Canada. Being a report by Sir George Murray for the Dominion Government, Ottawa, Canada.

Cleveland Engineering Society.—The annual register of the officers and members, and the Constitution for 1912 and 1913, Cleveland, Ohio.

Foundations and Machinery Fixing. By Francis H. Davies. Published by Constable and Co., Ltd., London, Eng. A practical handbook for practical men. Price 60c.

CATALOGUES RECEIVED.

Water Wheels, etc. Boving and Company, Limited, Union Court, Old Broad Street, London, E.C.; Canadian office, the Canadian Boving Company, 162 Bay Street, Toronto, forward pamphlet illustrating the different apparatus and machinery manufactured by them.

Everything for Blue-Printing. The C. F. Pease Company, 166 West Adams St., Chicago, forward catalogue illustrating their different machines for blue-printing.

Lock Metal Forms. The Hotchkiss Lock Metal Form Company, Binghamton, N.Y., forward catalogue illustrating their steel forms for walks, curbs and gutters, wall forms, etc.

Garbage Disposal Plants. The C. O. Bartlett and Snow Company, Cleveland, Ohio, forward their catalogue, No. 29, illustrating different garbage disposal plants installed by them.

Hydraulic Machinery for Rubber Mills. R. D. Wood and Co., 400 Chestnut Street, Philadelphia, Pa., forward their catalogue, No. 7, showing special hydraulic machinery made by them for the manufacturing of celluloid and rubber goods.

Block Sheaves and Wire Rope. The Clyde Iron Works, Duluth, Minn., forward a handsome little catalogue illustrating their different types of block sheaves and wire rope.

Sewage Disposal. Jones and Attwood, Limited, Stourbridge, England, forward catalogue illustrating different types of installations of their apparatus for the sewage disposal of country houses and institutions.

"Lever Punches and Shears," a 40-page catalogue, has just been published by the Watson-Stillman Company, 50 Church Street, New York. Many types are illustrated and tabulated. Free copy mailed on request.

Water Filtration. The New York Continental Jewel Filtration Co., New York, the designers of the Filtration equipment for the East Jersey Water Company, Little Falls, N.J., forward a very complete description of the plant, together with table showing the average result obtained from the filter.

"Ruggles-Coles Road Machines" is the title of a 12-page pamphlet just issued by the Ruggles-Coles Engineering Co., 50 Church Street, New York, and the McCormick Building, Chicago. It contains information with illustrations of the Ruggles-Coles portable and semi-portable drying and heating plants for bituminous concrete work, and also describes the new Ruggles complete drying, heating and mixing plant outfit for road work. The pamphlet will be sent on request to any of the Ruggles-Coles offices.

Bulletin No. 105 Lackawanna Steel Sheet Piling has just been published by the Lackawanna Steel Company, Lackawanna, N.Y. This 28 page, 8 in. by 10½ in. bulletin shows in a clear and concise way the reasons for and values of the three principal types of Lackawanna steel sheet piling straight-web sections, such as were used in the raising of the "Maine," are used for ordinary work where the principal forces to be resisted are tensile or where the water-tightness is essential. Arched-web sections are of value where the piling must resist transverse bending forces, as in foundation pits. Steel piling protected by concrete, a new piling just put on the market by this company, is used for permanent levee constructions, revetments, etc. Illustrations in this bulletin show the piling in the act of being driven, braced, cut by the oxy-acetylene process, etc. A free copy will be mailed on request.

"Scale Removal from Condensers," is the title of an attractive catalogue recently issued by the Lagonda Mfg. Co., of Springfield, Ohio. This book is more than a catalogue, as it contains a very interesting discussion showing the harmful effects of scale in condensers, how it decreases vacuum and increases the power of the auxiliaries. Interesting curves are also included showing the increased steam consumption resulting from the accumulation of scale in surface condensers. The removal of scale and other deposits from ammonia condensers, evaporators, etc., is discussed, and a complete line of cleaners illustrated for use in various kinds of condensers. Copies of this catalogue, No. O-1, may be had by addressing the Lagonda Mfg. Co., Springfield, Ohio.

CHANGES IN STAFF OF GRAND TRUNK.

The following changes in the administration of the Grand Trunk Railway System are announced by vice-president H. G. Kelley.

Mr. L. Harold is appointed Superintendent of Transportation of the eastern lines with headquarters at Montreal, and Mr. F. L. C. Bond becomes Division Engineer of the same lines with the same headquarters. Mr. G. Beckingham becomes Superintendent of track of the eastern lines, and Mr. J. H. Johnston Superintendent of bridges and buildings. Mr. J. J. Connolly, Superintendent of the Montreal division, and Mr. R. W. Scott, Superintendent of Montreal terminals. Mr. J. Caldwell succeeds Mr. C. S. Cunningham as Superintendent of the Detroit division and Mr. J. Ehrke is the new head of the Chicago division. Mr. C. S. Ogilvie becomes Assistant Engineer of the Belleville division.

Mr. T. Cushin is appointed Trainmaster of the third district, with headquarters at Richmond, Que., and Mr. R. P. Smallhorn is appointed Freight Agent at Montreal.

COAST TO COAST.

Moose Jaw, Sask.—The Civic Improvement Committee of this city have asked for the following amounts as part of the civic improvement plan for 1913: Light and power, $185,000; fire and buildings, $105,000; sewer and water, $200,000. These amounts will be asked for in the usual by-law procedure.

Montreal, P.Q.—The new bridge over the River St. Lawrence between the Highlands station and Caughnewaga, erected by the Canadian Pacific Railway, is now open and the double tracks are in operation. The double tracking of this bridge has involved the expenditure of three millions of dollars.

Vancouver, B.C.—The British Columbia Transport Company, Limited, will erect a cement plant at Alberni very shortly. A deposit of the raw material has been found in the neighborhood of Port Alberni and if the final tests prove satisfactory the business of manufacturing cement will be started at once.

Winnipeg, Man.—The gross earnings of the Winnipeg Electric Railway Company have nearly doubled in two years, according to the official statement submitted to City Treasurer Thompson by G. A. Henson, secretary of the company. The gross earnings for 1912 for street car business alone amounted to $2,114,947.93. In 1910 the gross earnings were $1,265,874. The increase in two years is $849,073.

Moose Jaw, Sask.—In the recent figures shown of the growth of Western Canada in building permits granted for the year, Moose Jaw figures prominently. The amounts granted to several cities are as follows: Moose Jaw, $15,275,795; Medicine Hat, $2,836,239; Prince Albert, $2,006,925; Lethbridge, $1,358,250. The total for the year has exceeded the $200,000,000 mark, and a gain of almost $60,000,000 has been made.

Calgary, Alta.—The $2,500,000 contract of the Westinghouse, Church, Kerr Company, of New York and Montreal, for the construction of the new Ogden locomotive and car shops for the Canadian Pacific Railway Company is now about 90 per cent. completed. When the plant is working to capacity the pay-roll for wages alone will be from $8,000 to $10,000 per day. The locating of the shops here will swell the population of Calgary by thousands.

Montreal, P.Q.—Engineers and officials of the Montreal Tramways Company have been gathering data for presentation to the city council regarding congestion of down-town street car traffic. It will be impossible to operate cars on several of the streets unless they are enlarged and more loop lines are imperative. The company agreed to lay tracks on every street wide enough to operate their cars, providing they receive permits from the city to do so. Mayor Lavalee favors the appointment of an expert to report the best plan to remove down-town congestion which, so far, has baffled all attempts at solution.

Ottawa, Ont.—The Calgary, Edmonton and Fort McMurray Railway Company are obtaining a charter to build into the Peace River country, a line 2,300 miles in length in all, a regular transcontinental, or at least trans-Edmonton line, and is asking parliament for the right to use steam and electricity as it may see fit. More than that, it is securing the right to develop electricity and to distribute it along the line of its route to municipalities and private parties. This is a striking example that railway builders of to-day are recognizing that electricity is the coming motive power.

PERSONAL.

MR. GEORGE POWELL, deputy city engineer, Toronto, Ont., was offered a position as works commissioner of Prince Albert, Sask., at $6,500 per annum, but has refused the offer.

JOHN D. WATSON, M.Inst.C.E., engineer to the Tame and Rea District Drainage Board, has been engaged to advise the Metropolitan Sewerage Commission of New York on the disposal of the sewage of that city, and has just left for New York.

FRANCIS P. SMITH, M.Am.Soc.C.E., chemical and consulting paving engineer, New York City, on January 21st delivered an illustrated lecture on "Maintenance of Sheet Asphalt Pavements," before the graduate students in Highway Engineering at Columbia University.

PHILLIP P. SHARPLES, manager of the Tarvia Department of the Barrett Manufacturing Company, and Mr. F. S. Hutchinson, manager of the Tarvia Department of the New York office of the company were in Toronto last week, in connection with the Tarvia interests of the Paterson Manufacturing Company.

FRANK P. JONES, general manager of the Canada Cement Company, and president of the Canadian Venezuela Iron Ore Company, has just returned from a two months' absence from Montreal, spent in Venezuela inspecting the company's mines. Mr. Jones stated that there is a big market for their ore in and about Philadelphia. At present the company is shipping 3,000 tons per month, and before the end of the year will be exporting 50,000 per month.

HOWELL T. FISHER, tunnel engineer for the Mount Royal tunnel of the Canadian Northern Railway, was a recent visitor to The Canadian Engineer office. Mr. Fisher is a member of the American Society of Civil Engineers and of the American Institute of Mining Engineers. He got his first engineering training at Lehigh University, South Bethlehem, Pa., which is now presided over by Dr. Henry S. Drinker, who is an acknowledged authority on tunnels. Mr. Fisher has seen service with the Isthmian Canal Commission, the United States Geological Survey, the Denver Water Company, etc. He was also associated with Mr. Stephen P. Brown, the chief engineer of the Mount Royal tunnel, in the construction of the Fourth Avenue subway, Brooklyn, the East River division of the Pennsylvania tunnel, and the Pennsylvania-New York crosstown tunnel.

CANADIAN SOCIETY OF CIVIL ENGINEERS, TORONTO BRANCH.

The annual meeting of the Toronto Branch was held at the Engineers' Club, Thursday evening, January 23rd. The following officers were elected for 1913: Mr. E. A. James, B.A.Sc., was elected chairman for 1913. The other officers are as follows: Secretary-treasurer, A. Garrow; executive committee, P. Kemble, E. T. Brandon, W. A. McLean, and the retiring chairman, T. C. Irving, jun.

MEETING OF THE IDAHO CEDARMEN'S ASSOCIATION.

At the annual meeting of the Idaho Cedarmen's Association, held in Spokane, Tuesday, January 14, 1913, the following officers were elected for the ensuing year: President, H. C. Culver, Sandpoint, Idaho; vice-president, M. P. Flannery, Spokane, Wash.; secretary-treasurer, R. L. Bayne, Spokane, Wash.

W. M. Leavitt and E. A. Lindsley, with the president as member ex-officio, were appointed to be a committee to draft a constitution and by-laws for the association.

TORONTO CIVIC GUILD.

At the annual meeting of the Civic Guild held last week, with Mr. C. H. Mitchell, C.E., presiding, the following officers were elected for 1913:—President, James B O'Brien, K.C.; first vice-president, C. H. Mitchell; second vice-president, Edmund Burke; secretary, R. J. Dilworth; executive committee—John Firstbrook, J. B. Laidlaw, W. Ford Howland, J. H. Gundy, C. B. Lowndes, H. W. Barker, W. E. Harries and A. Frank Wickson; auditors, J. M. McIntosh.

Mr. F. B. Fetherstonhaugh thought the Guild might take up the question of smoke prevention with a view to having legislation passed compelling the Canadian Pacific Railway, Grand Trunk Railway and Canadian Northern Railway to use electric locomotives for shunting purposes within the city limits. As the subject was raised at a late hour, discussion was deferred until the next meeting.

COMING MEETINGS.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Me g of the Association will be held at the University of Illinois, Campaign-U r Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March, 3, 4 and 5, 1913, in the Green Room, Congress Hotel and Annex, Chicago, Ill. Secretary, Will P. Blair.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annu Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway, Secretary. Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—P ident, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Feb. 6, 1913 Contents of this issue on page 279

The Canadian Engineer

An Engineering Weekly

CONSTRUCTIONAL FEATURES OF A LARGE REINFORCED-CONCRETE DOME.

BY L. R. W. ALLISON

The Second Church of Christ Scientist, Los Angeles, California, was recently erected on West Adams Street at a cost of $300,000, and is probably the finest edifice of its denomination in the west. The structure, shown in Fig. 2, is of reinforced concrete and occupies a ground area of 100 by 150 feet; it was built by a popular subscription building fund. In form it is the arche-type of a Greek cross, offering in treatment many distinctive constructional and architectural features.

The church auditorium proper, 92 by 106 feet, has no column or gallery obstructions, and is surmounted by a hemispherical reinforced concrete dome (Fig. 1) 70 feet in diameter. The crown of the dome is 75 feet above the floor line, and at part way of its periphery, thirty-one stained glass sash are placed to afford an upper source of light.

Dome Support.—The supporting structure for the dome, acting as a unit, consists of concrete heavily reinforced with riveted sections. Four columns, as the respective corners of a 70-foot square, carry the load of dome structure and transfer it to the ground. Such columns (Fig. 3) are of concrete section twenty-eight inches square. They are composed of four 3 x 3 x 3/8 inch angles, doubled latticed with 2½-inch flats, and at the outside corners for additional reinforcement 3 x 3-inch T-bars are placed.

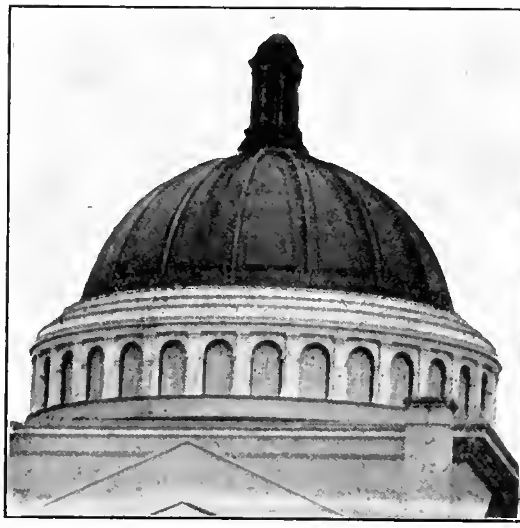


Fig. 1.

Fig. 2.

At the roof plane of the wings a girder framing is constructed, as shown in plan (Fig. 4). Four large girders "A" form the sides and rest directly upon the columns; at a forty-five degree angle at each corner, smaller built sections "B" are placed, and framing into these latter, as shown, eight small beams "C," approximately 14 feet long, complete a sixteen-sided polygon. This supporting structure is finished flush on top, the smaller girders being carried on brackets, and as a whole sustaining the main base of the dome.

The cross-section (Fig. 5) diagrammatically shows the construction of the main girders "A." The top chord is composed of two 6 x 4 x 3/8 inch angles, placed 12 inches apart and fastened with batten plates. The bottom chord comprises two angles, one 6 x 6 x 3/8 inch and one 6 x 4 x 3/8 inch, similarly spaced and battened. The verticals consist of two 3 x 2½ x 5/16 inch angles at the outer portion of the truss and two 2½ x 2 x 5/16 inch angles at the middle section, while the diagonals are formed of two 3 x 5/16 inch bars at outer end and two 2½ x ¼ inch bars at middle bay, correspondingly. All sections are riveted together at the joints, and the ends of girder riveted to the columns. A system of 1½-inch twisted rods for further concrete reinforcing is employed, as will be noticed.

The smaller girders "B" are of like construction, similarly reinforced with twisted rods, and riveted at ends into the main girders. The built beams "C," (Fig. 4) have top and bottom chord each of two 2½ x 2½ x 5/16 inch angles, battened 12 inches apart. There are two vertical and three diagonals in each constructed beam, the former consisting of two 2½ x 2 x ¼ inch angles, and the latter two 2½ x ¼ inch flats.

This steel supporting structure was erected successively, and then concreted as a unit, the timber form work for the latter being supported by the steel frame.

Dome Construction.—The forms for the dome were made in sections and located in position as the work progressed. The base of the timber forms rested upon studs concreted in the girder unit for such purpose. For three feet above the riveted section and concrete support, the dome is 16 inches thick, and is reinforced for such distance with two 1-inch bars at the base and six similar bars through the vertical or outer face.

The following section, about 8 feet in height, consists of thirty-two small posts, spaced equally about the circumference to serve for window jambs. These posts, 12 x 14-inch

in size, are composed of four ¾-inch twisted rods, additionally wrapped with No. 6 wire. The rods extend into the upper and lower bearing surfaces for a distance of about 6 inches to insure proper bonding. For 2 feet above this window area, the dome is of similar thickness, 16 inches, and is reinforced with five 1-inch twisted rods.

As will be noticed in Fig. 2, the remainder of the cupola rests on this 16-inch base, and forms a unit ring in itself. At the base, this dome proper is 8 inches thick and tapers to a 4-inch thickness at the crown. It is reinforced both vertically and horizontally with ¼-inch twisted rods, for the former at 18-inch centres, and for the latter in spaces varying from 6 inches at base to 12 inches at crown.

This complete section of the dome is covered with heavy-gauge copper which, as the crown is approached, assumes the shape shown by the wood frame in Fig. 5, this latter being added after construction was under way to insure a more graceful curve than originally planned. The wood frame consists for the most part of timbers 2 x 10-inch, 1 x 8-inch, or less, and is covered with 1-inch vertical sheeting. Surmounting the crown is a pinnacle of copper covering corresponding to the dome proper, as will be seen in Fig. 2.

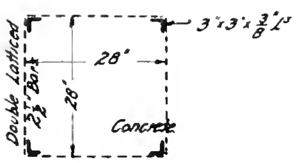


Fig. 3
Column Section

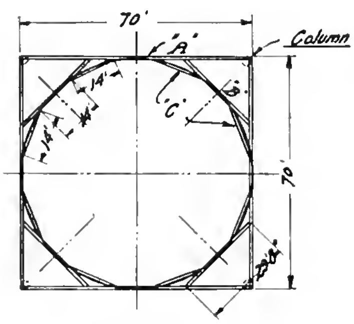


Fig. 4
Plan- Concrete Girder Support

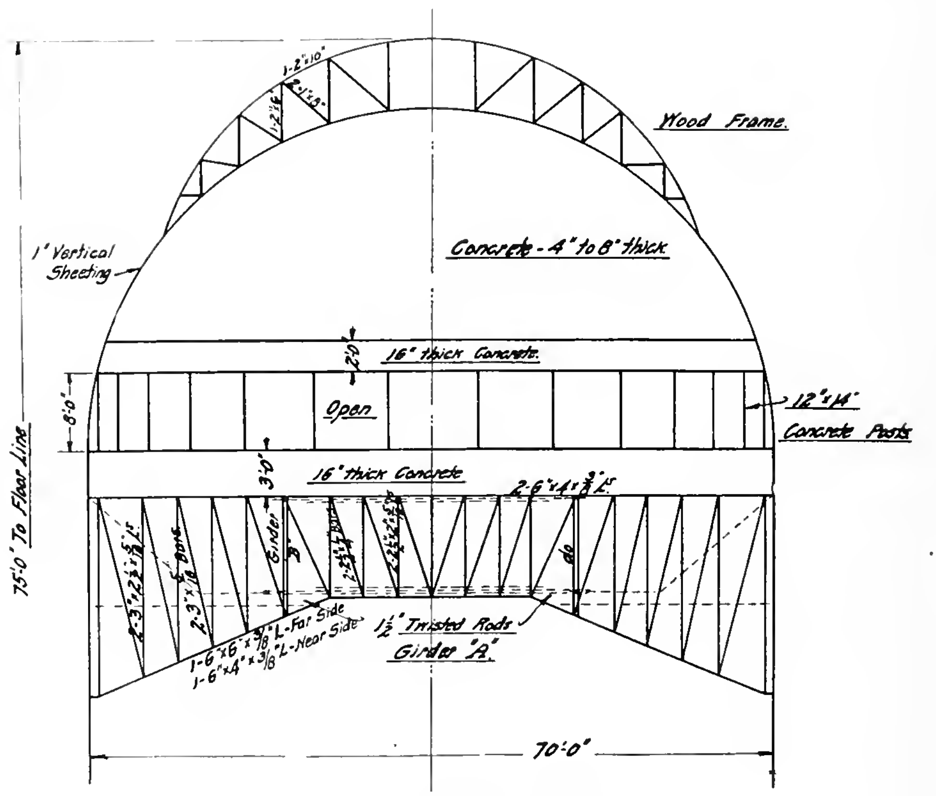


Fig. 5.—Diagram, Typical Section.

All horizontal reinforcing bars in the dome sections were placed near the outer edge of the work. The gravity system of pouring concrete was employed, the mixture was hoisted to a point above the work and conveyed to its respective location by means of a swivel-jointed, sheet-iron pipe. The forms for the dome construction were left in place for about three months.

The exterior finish of the church is a combination of terra-cotta and white enamel brick. This facing is fastened to the concrete body by galvanized wires, placed in position as the concreting progressed.

A. F. Rosenheim and A. C. Martin, both of Los Angeles, were associated as architect and engineer, respectively, of the edifice; the construction was carried out by the C. J. Kubach Company of the same city.

THE INTERNATIONAL GEOLOGICAL CONGRESS

By H. Mortimer-Lamb.*

Within the last twenty or twenty-five years, the science of geology has developed in a direction that has brought it into direct and serviceable association with those classes of commercial enterprise that are dependent on engineering. While this is especially true in respect of mining, it applies almost equally to railroading, municipal engineering, and other activities of a like nature. The dependence of mining on geology is attested, for example, by the fact that a geologist is now invariably included on the permanent staff of every mining corporation of importance; and the demand in recent years for the services of capable men to occupy such positions has been quite out of the proportion to the supply. It is recognized universally, in short, that the debt of the mining industry to geology is enormous, and the obligation continues to increase steadily. This largely explains the circumstance that the invitation to the International Geological Congress to hold the next meeting in Canada was made, not only at the instance of the Canadian and Ontario Governments, and of the Royal Society of Canada, but at that of the Canadian Mining Institute, an association representative, in a truly national sense, of the mining industry of this country. It is believed that this meeting will immensely benefit mining in the Dominion. From the educational and the scientific standpoints, much is to be expected from the interchange of views on Canadian conditions and problems, by men of international reputations. On purely commercial grounds, the interest and attention that will be directed to the mineral resources and to the opportunities for the investment of capital in mining undertakings in Canada, in themselves fully justified the extensive preparations that are being made and the expense that is being incurred in anticipation of the event. Judging from the character of the attendance in the past, almost every civilized nation will be repre-

* Secretary, the Canadian Mining Institute, Montreal.

sented at the Canadian meeting by men of recognized eminence, including distinguished government officials, geologists and mining engineers in consulting practice, geographers, great educationalists and writers of text-books. Thus surely never a better, a more effective opportunity has presented itself of providing for the wide-spread disseminations of authoritative information on Canadian resources and potentialities.

On these grounds, a general appeal for sympathetic co-operation is made to all classes and to the mining community in particular. The congress has held many meetings in other countries. In all, it has been welcomed with open arms. That record must be at least maintained.

Meanwhile, before proceeding to recount what progress has been made so far with the arrangements for the meeting and for the instruction and entertainment of the visitors, a word or two should be said concerning the International Geological Congress itself. In the year 1876, at the International Exhibition at Philadelphia, there was displayed a collection of geological maps and sections from both America and Europe. It had the effect of impressing on geologists who saw it the advantage of providing opportunities and means for comparative study; and in consequence, in August, 1876, at the annual meeting of the American Association for the Advancement of Science, at Buffalo, under the presidency of Prof. William B. Rogers, the project of the foundation of the congress was broached, received favorably, and a committee was appointed to arrange for the first meeting, held two years later in Paris. It is worthy of remark that the secretary of the committee in question was that distinguished chemist and geologist, Dr. T. Sterry Hunt, who from 1847 to 1872 was chemist and mineralogist to the Geological Survey of Canada. The objects of the congress may be very briefly and succinctly summarized in the general statement that by means of the periodical meetings the results of knowledge acquired in any one country are given a universal application and significance. The congress endeavors to provide, for example, for the adoption of uniform systems of mapping, nomenclature and classification of rocks, fossils and minerals; and in other directions broadens the boundaries and extends the usefulness of geological science. One achievement, in particular that may be mentioned, is the compilation of a geological map of Europe, shortly to be issued; and it is now proposed to undertake the preparation of a similar geological map of the world.

The records of the meetings, which are usually held every three years, are shown in the following table:—

Number of Members, Delegates, Vice-Presidents and Countries Represented at Each Congress.

Congress	Year	Country	Members Enrolled	Members Attending	Delegates	Vice-Presidents	Countries Represented
1st	1878	France	310		7	18	23
2nd	1881	Italy	420	224	23	19	23
3rd	1885	Germany	455	258	15	20	22
4th	1888	England	337	140	68	22	25
5th	1891	U.S.A.	546	251	39	31	24
6th	1894	Switzerland	401	273	18	15	20
7th	1897	Russia	1037	704	139	40	27
8th	1900	France	1016	461	80	46	31
9th	1903	Austria	664	393	39	25	30
10th	1906	Mexico	707	321	83	27	33
11th	1910	Stockholm	857	650	262	74	36

As will be noted, the congress, so far, has met only twice on this side of the Atlantic.

Socially and scientifically, the last meeting in Sweden was notably successful. The opening session was attended by the King of Sweden in person, while at the sessions devoted to the discussion of economic problems, a number of the Cabinet Ministers proved their interest and sense of the importance of the occasion by their presence. The arrangements for the conduct of the meeting, for the entertainment of the visiting scientists, and in connection with the several excursions, were planned and carried out with extraordinary ability and precision; and it will require every effort on the part of Canadians to even equal the standard set by Sweden in these respects. It is scarcely necessary to say, however, that no pains are being spared by an energetic and representative executive committee, to which has been entrusted the task of preparing a programme for the twelfth or Canadian meeting of the congress.

The excursions, more especially on the occasion of recent meetings, have been given special prominence. These have two main purposes; one to illustrate, so far as possible, the subjects discussed; and the other to afford visiting members the opportunity of studying the features of geological interest peculiar to the country in which the congress assembles. In connection with the arrangements for the Canadian meeting, provision has been made for over thirty excursions to mining districts and other localities of geological interest in Canada, between the extreme east and west of the continent, and northward as far as Dawson. It is computed, on the basis of the numbers in attendance at former meetings, that the representation from abroad, at the Canadian meeting, will not be less than, and may exceed, seven hundred. Each excursion will be under the leadership of a duly qualified guide, who will also be competent to point out and discuss the phenomena constituting the point of interest in each instance. Obviously, the planning and effective conduct of a series of excursions on this scale is no light undertaking; but with the assurance of local aid and co-operation, the difficulties should not prove insuperable.

The Swedish meeting was marked especially by the publication of a monumental work on "The Iron Ore Resources of the World," to which reports on the distribution and supply of iron in the respective countries were contributed by eminent authorities. The executive committee of the twelfth congress are to be very heartily congratulated on the decision to emulate this example by undertaking the compilation of a companion work on the "Coal Resources of the World." Incidentally, this report should serve to direct wider attention to the magnitude and value of Canadian resources. The subject of coal resources and supplies will, moreover, form one of the principal topics for discussion at the meeting in Toronto; while other topics of no less economic interest, notably that of the influence of depth on the character of metalliferous deposits, are to be debated.

It is unnecessary here, however, to further discuss details, the purpose of the present notes being to give merely a general idea of the aims and work of the congress and of the significance attaching to its meeting in this country. With a proper realization of the importance of the occasion, the mining men of Canada, no less than the public generally, may be trusted to cordially co-operate with the congress officials in making the Canadian meeting an unqualified success.

Further information may be obtained by applying to the secretary, Twelfth International Geological Congress, Victoria Memorial Museum, Ottawa.

REPORT OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

Report of Proceedings of the Twenty-seventh Annual Meeting of the Society, held at 413 Dorchester Street West, Montreal, on Tuesday, January 28th, 1913.

The President, Mr. Wm. Francis Tye, called the meeting to order at 10.30 a.m.

The first business was the reading of the minutes of the last meeting.

The Secretary then read the minutes, which the meeting confirmed.

The President stated that he was requested to call attention to the Introduction or Reception Committee and to its functions. As ordered at the last meeting an Introduction Committee had been appointed, and the members of it are, Mr. Jamieson, Mr. Lewis Skaife and Mr. Francis. If any of the gentleman would like any information or introductions, one of these gentlemen would be glad to do anything for you.

NOMINATION OF SCRUTINEERS

The following gentlemen were elected scrutineers for the election of officers, etc:—Mr. James Ewing (Chairman), S. Blumenthal, A. R. Ketterson, E. Fiset and Mr. Bates.

AMENDMENT TO BY-LAWS COMMITTEE

The following gentlemen were elected:—Mr. Openshaw (Chairman), Mr. M. A. Downes, and Mr. G. E. L. Mallory.

SPECIFICATIONS COMMITTEE

The following gentlemen were elected:—Mr. E. S. M. Lovelace (Chairman), Mr. Shanly and Mr. Oliver.

REPORT OF COUNCIL

The next business was the reception and adoption of reports. The first was the report of Council. The President asked if it had been distributed.

The Secretary (Prof. McLeod) Stated it had been distributed to the members and that it might be taken as read.

The President said this report of Council was very long and he thought they might take it as read. It would take up too much time to read it, and they all had copies of it. There should be a motion to receive this report. On the motion of Mr. T. C. Irving, seconded by Mr. Hunter the report o Council, as printed, was received.

The President said that they should first take up the report of the Council and afterwards pass on to the report of the Library and House Committee, and the other Committees. That report of Council ends on page fourteen, and the meeting must confine their discussion first of all to that.

The President asked if there were anyone wishing to say anything in regard to this report?

Mr. McNab said that he noticed the third paragraph dealt with the death of twenty-nine members. It seemed to him it would have been well if they had had the names of the departed confreres. Among those who were announced as deceased was one who was also a member of our Society. He referred to the late lamented Mr.Chandler. He would ask the Secretary to read the names of those—there are only twenty-nine—who have gone beyond.

Also, in the third paragraph it says that the number removed from the rolls aggregates forty-five. He would like to know what proportion of those forty-five were removed by straight resignation and what proportion by non-payment of dues, or if the two reasons go together.

The Secretary, answering Mr. McNab's questions as to the sub-division, there was a meeting some three years ago at which a statement was made to the effect that one gentleman had been removed for non-payment of dues and a certain number had resigned. That was taken exception to, and since that date they had been combined.

The Secretary then read the list of those who have died

Mr. Irving said the name of Mr. C. Beresford Fox of Toronto was not mentioned

The Secretary stated that he had nc information of that. He then read the list of resignations.

Mr. Mitchell asked if these were all resignations.

The Secretary assented and added that they are mostly students.

Mr. Mitchell felt that was rather a large number of resignations.

Could the Secretary give the proportion this year in comparison with former years, say five or six years ago? Was this number of resignations larger than usual, or smaller than usual; also, are these gentlemen those who are engaged actively in engineering work, or are they letting the Society go just out of lack of interest, or do they give reasons, such as having moved away, or having become engaged in other pursuits?

The Secretary stated that he could give detailed information if he referred to the correspondence. Answering Mr. Mitchell's first question, he did not think the number of resignations of corporate members has been as large as usual. The number of students is somewhat large because the Society are continually pressing them for payment of their dues, and they are continually going off into other lines of work than engineering and cannot make the transfer to the higher grade. Perhaps they do not desire to, but in many cases they cannot do so. That accounts for the large number of students who have resigned, but the number of corporate members is small. There are only five of the latter altogether. The actual causes for their resignations can be given, if required.

Mr. Leofred asked if the corporate members resigned because they think the Society is not useful to them, or something like that. They might say something in their letters to that effect. It would be interesting to know what they say.

The President stated that so far as he recollected he did not think they had had that advanced as a reason for any resignations during the year. It would take a very great deal of labour at the present time to produce all the reasons for the various resignations because it would be necessary to go through all the correspondence for the year.

Mr. Vaughan called the meeting's attention to the fact that this year both for non-payment and resignations only two members left, and 27 came in.

The Secretary stated that the actual number of those who were removed for non-payment of dues was 17 associate members, 2 juniors and 27 students. Some of these on the former list would exceed this return because the total right up to the year was now presented and was not available at the time this report was made in the middle of December. This would be corrected.

Mr. Thomson stated that the Society did not charge fees enough to run the society.

Mr. McNab stated that he would like to refer now to page twelve, in which there was a copy of a letter sent by the Secretary as representing the Council, to the Premier of Canada, the Premier of British Columbia, and the Ministers of Public Works and of Railways and Canals of Canada. He would like to ask if the replies to that letter could be read for the information of this meeting?

The President stated that the Council had received several very strong requests, from the British Columbia branch especially, to prosecute this, and that they were pressing it as best they could.

Mr. Robinson then moved that the report of the Council concluded on page fourteen, be accepted.

Seconded and carried.

The President next took up the report of the Library Committee starting on page fifteen and ending on page twenty-two.

Lt.-Col. H. R. Lordly stated that the report of the Library Committee showed that thirteen books were purchased during the year, and fifteen were presented, making a total of twenty-eight. One hundred and twenty-five dollars was expended, of which forty-nine dollars was donated, making a net sum of seventy-six dollars given by the Society. It was possible that owing to the purchase of the new building and expenses incidental thereto the Council had not deemed it advisable to spend any more money, but he believed that there was a connection between this and the number of resignations which were quoted a few moments before. The Library is so poor, the additions to it are so slim, that when you spoke to a young

man, an associate member, and ask why he does not come around and take an interest in the Society, he says, "You have no library, and there is no necessity for my spending fifteen dollars when I get nothing for it." No doubt there were good reasons for the small expenditure this year, but he thought it should be taken up and discussed seriously.

The President stated he thought the library was the best engineering library in the country. (Hear! hear!) Of course, it was not anything like so large as the Society would like to have it, but they had not the money to make it what they thought it should be, and everyone knew the expenses of the Society were mounting up very fast, and in addition to that the Society are moving this year, so the Council thought it inadvisable to buy many more books until they were in the new building.

In response to a question by Mr. McNab, the Secretary stated that as to researches, there have been practically no demands. The Society has facilities for having a research made by the Nelson Bureau of Research, and practically that has not been utilised this year, nor was it last year. There were one or two enquiries last year, so the research feature has not been patronised, although the attention of members has been called to it. There was no record kept of attendance, but he thought the average number of readers would not probably be more than half a dozen a day throughout the year.

Mr. Kennedy stated with regard to the matter of research that he had had occasion to pay quite a considerable sum to the American Society of Civil Engineers because they have a larger library running back a longer time, but if the Society had affiliation with some other concern so they could have such research he thought they would rather have it made through their own library, and it ought to be published and kept before them so they could understand it practically. The American Society have a number of transactions publishing announcements on such matters, and they are put in every time and so kept before the membership.

The Secretary here read from the certificate of membership issued in favor of the Canadian Society of Civil Engineers by the Nelson's Encyclopaedia Library for Research:—"Members are entitled to the educational benefits and privileges of Nelson's Bureau of Research for special information. Upon request, members will be furnished with accurate information on any subject desired, agriculture, astronomy, art, chemistry, electricity, engineering, economics, geography, history, civics, literature, and all allied subjects. All questions will be answered without further charge." The working arrangement is that any question sent in to the Secretary is communicated to the Nelson Bureau for Research. Since this has been posted there have been six or eight enquiries. (Good!)

Mr. Mitchell stated that he was sure the members who are non-residents were delighted to hear of that arrangement.

There was another point which occurred to Mr. Mitchell. The various governments, the Provincial governments, as well as the Federal government, publish various reports throughout the year with reference to their works of an engineering character. The Province of Nova Scotia may publish reports with reference to its road and bridge structures. It may be that members who are living in Saskatchewan would like to know what reports have been published during the year. It is true that those members could write to the Provincial Engineers, but they do not know what is published without writing a letter. It would be a very convenient thing if the Library Committee, through the Council, would publish a list once a year of such publications.

Mr. T. C. Irving asked if it were possible to get the branches of this Society placed on the exchange list of other technical Societies so they might exchange transactions.

The Secretary stated that if they were liberally disposed they might. These exchanges with the Society here have usually been made on the basis of exchange. He supposed some Societies might be willing to send to all the branches. He would be very glad indeed to make the representation.

Mr. Mountain agreed with the last speaker. He thought the Society might ask if other Societies do that, and call their attention to the fact that if any branches of theirs are formed, this Society would reciprocate.

The President thought this a very good suggestion and would refer it to the incoming Council and Library Committee.

On the motion of Mr. Lumsden, seconded by Mr. Blumenthal the report of the Library Committee was accepted unanimously.

The President said that the next order of business was the financial statement which begins at page twenty-three and goes to page twenty-six.

Mr. Mountain moved the adoption of that report.

REPORTS FROM BRANCHES

The President stated that the next business before the Society was the reception of reports from branches.

Reports were then read from Victoria, Vancouver, Manitoba and Ottawa. The first three were accepted

Mr. Uniacke, before adjournment, asked if the Ottawa report was open to discussion.

The President stated that the discussion would come. If you want to discuss it you can do so after lunch, and the motion would then be put.

At one p.m. adjourned accordingly.

AFTERNOON SESSION—JANUARY 28th, 1913

The President said that the meeting had finished reading the report of the Ottawa branch. He understood some members wish to discuss that report.

Mr. Robinson moved in so far as the report deals with matters pertaining to a report of the transactions of the branch of Ottawa, that it be accepted, and that such matters as are contained in that report recommending to this body something to be done, be referred to the heading of "New Business," to come up at that regular time.

The President said that this was satisfactory.

Mr. Mountain asked if it were new business arising out of the adoption of that report. If it was anything to be discussed it seemed to him it should be before the report was finally adopted. The only thing he wanted to refer to was the question of the number of students in the Ottawa branch that have reached their limit of age, and should be transferred. On behalf of the Ottawa branch he would call the attention of the Society to that with a view to its being taken in hand. These men could not be allowed to remain as students and pay one dollar a year, and the branch be out of the receipt of their percentages as corporate members.

The President said that the Secretary had been hammering away at that question as hard as he possibly could. He thought it was also up to the members of the Ottawa branch to move a little in the matter.

Mr. Mountain stated that they could not do that. They had tried to do that and the members of the Society represented that the branch was usurping the powers of the parent Society. It must be done through the parent Society.

The President said that he agreed with that.

The Secretary said that perhaps Mr. Mountain knew that a final circular had been issued to all of the students. There were some six hundred on the list to whom such notices had gone, informing them that unless they make application for transfer to a higher grade, or show that, they are still eligible to remain as students, they will be removed from the list on the first of March. He also said that the Council referred the matter to the Society solicitor in order to ascertain whether it was competent for the Council to transfer such students without their application, and he informed the Council that it was not, that they must make application.

Mr. Mountain said that answered his objection.

The President added he thought the Ottawa branch and the other branches would help along in that matter by urging these student members to make application.

Mr. Mountain said with all due respect to the Chair, that was impossible. They had been called down for attempting to do it.

Mr. Braley, as Secretary of the Ottawa branch, said that they had tried to get these members to transfer, but a certain number of them said they did not have to unless they were forced to. In fact, the question had been brought up that the Society could not force them to transfer because the By-Law for the age limit was passed just lately.

The Secretary said that there was nothing in that.

Mr. Jas. White said that there was another way out of the difficulty. If in accordance with the By-laws it is impossible to force these men to transfer, to change the By-laws. He suggested leaving the matter in abeyance for twelve months, but he did not see any reason why the By-laws should not be changed twelve months hence, and then let the parent association take action. Mr. Mountain had put the matter concisely. He did not know that they could do anything more.

The President said there was no doubt the parent Society was doing everything it could in that matter, and would continue to do so.

Mr. Braley asked if the Society could refuse them the transactions.

The President answered no.

Mr. Irving asked if the Ottawa branch was doing anything to have the very interesting papers read before their branch published in the transactions. They were having great difficulty in getting papers in Toronto, the members seemed to be very busy, and they were rather envious when they heard of Ottawa's success in getting papers.

Mr. Uniacke said it was their endeavor to get all those who have read a paper or given an address before the Ottawa branch to put them in such shape that they could be submitted to the Secretary and to the Committee on papers of the main Society. They had had several cases of papers that had been accepted, and he believed the Committee on papers at present had one or two under consideration. A good many of the papers and lectures had been of such a character that it was very difficult to put them in proper shape for publication. For instance, the paper on wireless telegraphy was a running talk illustrated by apparatus, and several others that were illustrated by lantern slides formed more of a talk, and the discussion brought out almost as much as the paper itself.

The motion that the report be adopted was then put and carried.

Mr. Robinson said he would like to interpolate a request to the Chair to reserve two hours some time during this Convention in which new business could be taken up. He thought the branch at Ottawa would like to bring up some of their suggestions, and he was sure others would like to do the same.

Mr. Braley said he had a few suggestions to bring up later on.

The President said that the next business that was on would give the opportunity desired.

Were there any representatives of Quebec here who could tell the Society anything about their report.

Mr. Leofred said that the Secretary telephoned him yesterday afternoon that he would be there to-day with his report.

The President passed that in the meantime. Kingston was in the same condition. Were there any Kingston gentlemen there?

They would leave those, and if they should get them before the meeting is over they could deal with them.

Regarding the financial report which was referred to the auditors, they say there are some clerical errors in the report as printed. On page twenty-three in regard to receipts the figure $539.72 should read $539.27; and on the next page this $10,000. That $85,141.84 on each side under the head of "Receipts and Expenditures" should be $75,141.84. With those corrections the report is all right.

FINANCIAL REPORT

The President thought there was a good deal of room for discussion in regard to this financial report, and he would be glad to hear from different members regarding it. The parent Society had reached this point where it had got to do something, it had to increase its receipts and reduce its expenditures, and there did not seem any way of reducing the expenditure, in fact it ought to be increased.

Mr. Braley thought the fees would be considerably increased when they moved the students up to Junior Associate Members.

The President said they would drop a good many students in the process of doing it, and he did not think that would make very much difference.

Mr. Mountain thought if the proposed increase of fees went into force the Society would be in pretty good shape.

The President assented but said that might not pass. Where was the Society going to be then?

Mr. Vaughan said he thought the meeting should talk over this proposed increase of dues, because as had been said it was possible it might not pass. If that increase did not pass it was going to put the Society in rather a serious position.

The Society had had some figures prepared in connection with that which he would like to present to the meeting in order that, should that proposed amendment to the By-law be defeated, the gentlemen from the various branches might be better informed as to the idea of the Council in this matter, as it would certainly have to be submitted again next year. These figures would be printed in the proceedings. They had compared the American Society of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and our own Society, the Canadian Society of Civil Engineers.

The collections per member were: for the American Society of Electrical Engineers, $11 00; the American Society of Civil Engineers, $18.00; the American Institute of Mining Engineers, $9.50; the American Society of Mechanical Engineers, $17.25; the Canadian Society of Civil Engineers, $7.00.

The salaries paid per member are: for the American Society of Electrical Engineers, $2.25; the American Society of Civil Engineers, $5.20; the American Institute of Mining Engineers, $4.70; the American Society of Mechanical Engineers, $9.70; (He was a member of that Society); and the Canadian Society of Civil Engineers, $1.70.

The printing per member was: for the American Society of Electrical Engineers, $3.50; the American Society of Civil Engineers, $5.75; the American Institute of Mining Engineers, $4.60; the American Society of Mechanical Engineers, $10.70; the Civil Engineers of Canada, $2.30.

Those figures show how economically this Society is now being operated.

Another point that he wished to call attention to was the distribution of the $20,000 odd that went into the expenditure as outlined in the annual report. He had divided that into salaries, including legal and auditing expenses, which he considered a general charge very largely, charges of general benefit, such as printing the transactions, etc. He need not go over all these—but he had endeavored to take the charges of general benefit for the year amounting to $9,155. The headquarters expenses proper amount to $3,293.42, contributions to branches $2,810. That worked out about this way: Taking out total expenses, salaries are 24%, general expenses 45½%, headquarter expenses 16½%, branch expenses 14%.

Under the proposed new subscriptions the receipts as nearly as they could approximate from the headquarter expenses would be 23% and from branch members 36%, and from non-resident members 41% of the total. He had pro-rated the salaries equally among the headquarter, branch and non-resident members in proportion to the receipts from them; general expenses in the same way; the headquarter expenses entirely to headquarters, and the branch expenses entirely to the branches. The general result was that headquarters, from whom the receipts are 23%, take 31½% of the total; the branches, from which the receipts are 36%, take 39%; and the non-resident members, from whom the recipts are 41%, take 28½%. In other words, the branches were very nearly as well off, on the assumption that they were simply taking $12 for members and $10 for associates. Under the proposed By-laws the branches could, at their own option, increase that subscription to $15 for members and $12 for associate members, if they wanted the money, which would put them almost exactly on an equality with headquarters, and even then both branches and headquarters were getting more for their money than the non-resident members.

There was no doubt in his mind that this Society did need the headquarters. It was a benefit to the Society to have a headquarters maintained in proper shape. He did not believe they had gone to any unnecessary extravagance in the new quarters. They were the best that could be done with the money, and he did not think they could find them any too elaborate when the members saw them to-morrow. It was going to cost more to keep them up. As somebody said to-day, they should spend more on the library and that sort of thing. He was sure, from the inspection of the balance sheet they would find the increase asked for which simply put the members on an equality with members of other societies was not excessive. It was $15.00 for members. If they joined the American Society of Civil Engineers they would have to pay $25; the American Society of Mechanical Engineers, $15; the American Institute of Mining Engineers, $16.00; the American Society of Electrcial Engineers, $15.00; and the Canadian Society were asking $15.00. He could not compare associates, because their classification of associates was different from the Canadian Society. Their associates were people interested in the different professions, but not actively engaged in them; the Canadian Society Associates were actively engaged, but not of sufficient experience to be in the class of members. But if our associates are compared with the American Society of Civil Engineers associate members it is found that we were asking $15, and they were asking $25 for resident members. So even with this increase the Society were still well below other Societies of anything like an equal status, and it certainly would not give any more income than is necessary to carry on the affairs of the Society properly.

Mr. Vaughan thought that scheme of giving branches the option to increase their branch members to $12 and associate members to $10 so as to provide local funds for the branch would practically put their receipts almost on an equality with those of headquarter members, so far as what they get out of the total revenue of the Society compares with what the

headquarters members get out of the total revenue in proportion to the receipts from two different sources.

In connection with that the Council had recommended that the radius of branches be changed from fifty to twenty-five miles. That was with the idea that if the branch increased its subscription to $15 it might be very unfair to a member who was living thirty or forty miles away from headquarters to pay $15 instead of $10 for a non-resident member. There was no objection whatever to having members join out of the fifty miles radius, but they did not think it was fair to make it compulsory. He thought that was one of the things most criticised, but personally to him it was one of the fairest of the lot. If they get the option of $15 instead of $10 for a non-resident member the Society should limit the radius so that men who had no opportunity of getting in to the branches to take any interest in them should not be penalised an extra $5 for which they got no benefit.

Both branch and headquarters members were to-day, under this new schedule, getting more out of the Society in proportion to what they put into it than the non-resident members. (Applause.)

Mr. Uniacke said that Mr. Vaughan's schedule of fees and the reason therefor seemed to him to be very logical, but there was one point the speaker laid special stress upon, and that was that the branches at their own option should increase their fees on the same basis as the residents of Montreal, or the resident members. Under the wording of the By-law which had been sent out to be voted upon by the branches, it was a physical, if not a practical impossibility to do that, because it stated that in order to carry that it should be carried by two-thirds of all the members. In an ordinary ballot there was scarcely two-thirds of the ballots cast. So if it had stated "two-thirds of the members present at a meeting, after giving due and timely notice to everybody to attend that meeting," then there might be some chance of the branches carrying such a By-law.

There was one more point he wished to state. In the wording of the bylaw several clauses had been lumped together, and a man might have an objection to one or two clauses, but he had to vote "Aye" or "Nay" to the whole. Several had put it up to him that they would vote for this, but they had to vote for the whole thing together. Consequently if the By-law were defeated, it would be in a great measure due to that fact.

Mr. Vaughan thought Mr. Uniacke's point was very well taken about the two-thirds majority. It was a matter of common knowledge that it was almost impossible to get anybody to vote an increase of subscription by letter. He thought that amendment should be accepted and arrange to make a change in that, "that after due and proper notice two-thirds majority at the meeting should carry the change."

Mr. Coutlee thought that strong measures should be taken by the incoming Council to provide that either a larger percentage be given to the branches, or that a loan be made to them so they can put themselves on a respectable footing.

Mr. Irving asked if this were not a case where each branch could work out its own solution. As a matter of fact nearly all the members in Toronto pay thirty dollars to the Engineers' Club there. He thought in the case of Ottawa, Vancouver and Winnipeg, they could start an Engineers' Club and run the local branches of the Society as adjuncts to that Club.

Mr. Uniacke said in that regard that the Ottawa branch had under consideration combination of the three technical societies that were now in Ottawa for the joint use of rooms and lantern. They had a branch of the Mining Association on the same basis as the branch, and also an Association of Officers. They had a Committee on Rooms and the matter was now under consideration. If it went through it would help to put the branch on its feet, provided the members of the Ottawa branch, or the other branches, were a little more prompt in coming to time with their views.

Mr. Harkom said that the discussion was running on the question of headquarter's members and branch members. There had been a great deal said about not getting value for money from membership. He wanted, as a non-resident member, to put himself on record that he thought every member of this Society got full value for every cent he put into it. (Applause.) He thought it was worth $10 to any man to come here and attend these meetings. (Here! here!) For his part he did not think there should be the least little kick about increasing these dues. He had a certain amount of sympathy with these branch members from the fact that he really did not think they got quite enough to carry on their work. The work of the branches, really and truly was going to be, and is largely to-day, the true life of the Society. (Applause.) The branches should, he believed, get a little advance and if the Society was going to raise the dues of the branches two dollars, he thought they should have half of it added to their proportion.

The Secretary here stated that they were getting it all.

And if the fees were raised they would get the difference between the branch allowance for members and the headquarters allowance for members, $3.00. All that would go to the branch.

Mr. Uniacke said that was if the branches could carry that By-law.

Mr. Vaughan stated that he had omitted some information of what this increase would amount to. There would be 135 headquarter's members at $5.00, 400 branch and associate members at $2.00, and 200 headquarters associate members, or a total of $2,175.00 would be the estimated increase to headquarters on the general business of the Society, including all the general expenses. So it was not very much. It would add 12% towards the cost of operating the Society.

Mr. Mountain said that the trouble that had arisen between the branches and the parent Society was from the old By-laws under which they did not get any refund if a man was a year in arrears. He thought that was what started the whole trouble. In his opinion the Society was in a healthy condition, and it was representative of the engineers of Canada practising their profession to-day. He thought the members should keep it there

Mr. Braley thought everybody would agree that the branches to-day were helping to largely increase the membership. He had been Secretary in Ottawa for three years, and he thought they had pretty nearly corralled everybody there qualified to join the Society. Strong branches throughout the country were one of the greatest assets the Society could have. So long as the branches got a fair proportion of the increase he thought the branch members would be only too willing to increase the dues to the limit if they got a good return for the money.

The President here said this discussion was to a certain extent out of order, but he thought it was very important and he did not want to cut it short.

This question of fees was certainly very important. Canada was growing at a tremendous rate, and the Society wished to keep pace with the growth. The cost of living in every way was going up. It might be the cost of high living, not the high cost of living, but whatever it was it had the same effect on the Canadian Society of Civil Engineers as it had on everybody else and the Society must certainly have more revenue. It would be a calamity if this By-law were not passed. He was glad to have had the views of every man there. Speaking for the main Society, they certainly wanted to do everything they could for the branches, and he thought they could safely say there was no other Society of engineers that was doing anything like, for its branches, what the Canadian Society was doing.

Mr. Vaughan said that the Society might not have as good a branch organization as they ought to have, but they had a better branch organization than any other society he knew of.

Mr. Jamieson said that as the President had stated, the Society would be placed in rather a difficult position if the By-law should not be passed. If it should prove to be the case, he thought it would be well to put it before the members so they would know definitely the condition of affairs and what they were voting on. If that were done he did not think there would be any reasonable fear of its not passing. He did not think the members objected to paying towards ths support of the Society in a proper manner, but they ought to be given some information to base their judgment on.

The Chairman asked if the members were willing to adopt the financial report as corrected.

The motion was then put and carried unanimously.

The next business before the meeting was the reading of the President's address.

Mr. Mountain moved that the Vice-President, Mr. Vaughan, take the chair.

Motion duly seconded and carried.

Mr. Vaughan called upon Mr. Tye to read his address.

Mr. Tye then read his address

THE ADDRESS OF THE RETIRING PRESIDENT, MR. W. F. TYE.

GENTLEMEN :—

In rising to comply with the time honored custom of reading the President's address, I beg to thank you for the high honor you have conferred on me in electing me to the Presidency of our National Society.

Owing to my residence in Toronto, and to my absence in Europe during the first part of the year, I was unable to attend many of the Council meetings. The affairs of the Society were, however, so well looked after by the Council and our efficient Secretary, that I am sure the absence of the President was not felt.

I have great pleasure in congratulating the Society on its continued growth. Our Membership now amounts in all to over 3,000, and includes almost every engineer in the country. The expansion of the Society is a thing of which we must all feel justly proud. We have grown so rapidly that our old home has become too small for us, and we were very fortunate in being able to dispose of it on such advantageous terms at the very moment when a change had become necessary.

Our thanks are due to the Building Committee for the efficient and expeditious manner in which they have prepared a new residence for us; and I must congratulate the Society on the result of their efforts.

During the year the Council suffered a severe loss in the death of their friend and colleague, Mr. James N. Shanly. Mr. Shanly was a capable, conscientious engineer, and a favorite with all with whom he came in contact. He took a keen and intelligent interest in the Society's affairs. He was Chairman of the Finance and Building Committees, and much of the success of our new home is due to his untiring efforts.

When looking around for a subject on which to address you, my thoughts turn naturally to Railway Location, on which a great part of my professional career has been spent.

Transportation is one of Canada's greatest problems: our country is of vast area, the distances are great, the population sparse, and the traffic light; making the mileage and cost of railways high per head of population. On the other hand the growth of the country is and will continue to be rapid. A great problem is thus presented: how to build our railways that they may not be too expensive for our present requirements, and yet be capable of improvement to fit our future needs. Economics of Railway Location is, therefore, of even more than usual importance to Canada. The subject is so vast that it is only possible in such an address to touch its outer fringe; but it is so important to us all that even a few rudimentary remarks may be interesting.

While railways are built to serve the traffic requirements of the country, the immediate object of the promoters and builders is to make a profit, either on the construction or operation. This is undoubtedly true when built by private parties. When built by a Government, it is with the end in view that the people may make money either directly through the operation of the railway, or indirectly by the reduction of rates. It is, therefore, of prime importance that the engineer, whether he be working for private parties or for a Government, locate and construct the most economic road. The most economic road is not necessarily either the cheapest or most expensive, neither is it necessarily the one which may be operated at the least cost—it is in reality the one which is the most effective commercially or the one which will enable its owners to transport the largest amount of traffic at the lowest cost.

In order to ascertain that a railroad is most effective commercially, the features which underlie its commercial effectiveness should be understood. These are:—Gross Earnings Operating Expenses, and Fixed Charges; and are of importance in the order named Gross Earnings, which depend on the amount of traffic handled, is undoubtedly first. It is never advisable to build a railway unless there is or will be sufficient traffic to pay the Operating Eapenses and the Fixed Charges, no matter how cheaply or how well it can be built.

In new countries, such as most Canadian railways are built through, there is rarely sufficient traffic in sight to justify the construction of a road, so the promoters—whether they be a Government or private parties—must have faith in the project and must be able to justify to themselves, and to the investing public, the possibilities of paying dividends.

Engineers are sometimes, though rarely, consulted in the early stages of the project to report on the traffic possibilities of the route. The usual way is for the promoters to decide for themselves that a road between certain terminals is commercially desirable, and that there is or will be sufficient traffic on such a route to justify its construction. Engineers are then employed to survey and construct the road. The question should at once arise with the engineer—how the railway can be so located as to make it the most effective commercially, or how to get for the promoters the most profitable traffic. No matter how this problem is stated, it finally resolves itself into this:—if the promoters be private parties, how can the road be so located and built that the most interest can be earned on the money invested—or if a government, to transport the most traffic at the least cost? The answer in either case would be the same, for, if it is so located that it may handle the most traffic at the least cost, it will, if properly managed, make the most interest on the money invested.

The first problem the engineer has thus to face is how he can so locate the road between the given terminals as to get the most profitable traffic. The route which takes in the greatest number of towns, or which goes through the best land, if the country be unsettled, should be the first examined. A mistake frequently made is to locate the road within a mile or two of an important town in order to decrease distance or avoid expense. The cost of handling traffic is the total cost from the door of the consignor to the door of the consignee, and rates on that basis must be equal. The added charge for cartage is at times so large as to wholly destroy the business of the badly placed line and give it to a competitor more favorably situated, or if it be not wholly destroyed, the additional cartage and delivery charges eat up the profits.

Where traffic is light, and train loads less than the rated capacity of the locomotive, the cost of handling additional traffic is much less than is the ordinary train mile cost. It should be figured in equating the value of a change in location which increases traffic at 50% of the usual train mile cost. In this respect it should be remembered that deviations from the direct route do not always materially add to the length of the line.

In order to locate a railway so that it may be commercially effective it is first necessary to know what the volume of traffic is likely to be, whether it is immediately available, and at what rate it is likely to grow. The best way to ascertain this is by comparison with roads through the same or a similar country. A road through a country most nearly approximating that to be traversed should be selected for examination, and its traffic for previous years studied. If, for any reason business is likely to be materially greater or less than on the road under examination, due allowance should be made.

All railways are now required to make yearly reports to the government, and such statistics should be examined as well as those published in the Railway Companies' Annual Reports. The average train load and the ruling grade should be studied, and finally the average number of trains per day should be ascertained. It must be remembered that though the traffic is rarely balanced, that is, that there is seldom as much tonnage moving one way as the other, the number of trains each way must within narrow limits be the same. It is not always easy for an outsider to ascertain the number of trains over any given railway, as railway statistics are not published in this form, but every effort should be made to arrive at it as closely as possible.

Having obtained this information, and having determined how the traffic on the proposed road will compare with that on the road under examination, some approximation of the ruling grades on the road in view should be arrived at. If different from those on the route with which comparison is being made, the number of trains per day each way on the proposed road should be increased or diminished accordingly.

While this method of ascertaining the number of trains per day is only approximate, it is certainly much more accurate than to attempt to make an independent estimate of the gross tonnage on the new road. The rate of growth of traffic should be similarly ascertained, as a railroad should be built not only to take care of the present traffic but also that of the road in the reasonably near future.

Cost per train mile is the basis of all economic comparison, as the effect of the number of trains on the cost of operation is much more direct than

is the actual tonnage handled. The cost per train mile should thus be ascertained with reasonable accuracy. The Annual Reports published by the Railway Companies usually give these figures; if not, the reports of the Inter-State Commerce Commission give this information for every railroad in the United States. From this mass of statistics the train mile cost of the most nearly similar road should be taken and assumed as the train mile cost of the proposed road. It must also be remembered that these costs are increasing rapidly, the average for the whole United States for the year ending June 30th, 1896, being 95 cents, while for the year ending June 30th, 1910, it had increased to $1.49.

Equipped with this information as to the sources of traffic, the estimated average number of trains per day, and the probable cost per train mile, the engineer is ready to make a reconnaissance of the country to be traversed. The reconnaissance should always be of an area rather than a line. An area wide enough to take in any possible line should be examined. All combinations of probable lines should be studied. As the reconnaissance proceeds a map of the country should be made showing the details of the topography by contours ten to fifty feet apart; the elevations of controlling points should be shown with the greatest attainable accuracy. From such a map carefully prepared all lines and combinations of lines can be studied. Approximate condensed profiles can be drawn, and distances, grades and costs can be approximately asscertained. With such information, the choice of routes can usually be narrowed down to one or two, or in rare instances to three lines over which it is necessary to run surveys.

The value of a proper reconnaissance cannot be too strongly insisted upon. It is owing to the lack of it that the graver errors of location are usually due, such as the selection of an improper route or ruling grade, passing of traffic centres, &c. There is no way in which money can be so profitably spent. Great pains should be taken to secure the most expert engineer for this class of work. In engineering and economic importance reconnaissance far outranks location or construction. It is not an exaggeration to say that for every dollar which an engineer can save on construction, he can save five on location, and ten on reconnaissance.

The really essential factor in a location made for freight traffic is the ruling grade. The maximum is not always the ruling or limiting grade, as it might be operated by the aid of a helper engine, in which case it may not limit traffic. A very long grade of a lower rate may, by taxing the boiler capacity, become the ruling grade instead of a shorter steeper one. To ascertain the economic value of any change in grade, or to compare two different grades, the number of round trips per day required to handle the given or estimated traffic should be ascertained. The difference will be the saving in trains each way per day. This multiplied by the ascercertained cost per train mile, by twice the length of the Division in miles and the number of days in the year, will give the annual saving. Capitalizing at the proper interest rate will give the capitalized value of the better grade. If the additional cost is not greater than the capitalized value when properly equated for distance, rise and fall, curvature, etc., then the lighter grade is an economic one, and should be adopted.

As many items of expense will not be affected by changes in the number of trains, the saving per train mile for a train eliminated is not as great as the cost per train mile for the entire traffic. The saving is in reality in the neighborhood of 50%, and this percentage of the ascertained total train mile cost should be used in estimating the economy due to a difference in ruling grade.

In figuring on the economics of a grade reduction on an old road where the traffic and the average number of trains per day are known, it is essential that the actual loads hauled by each locomotive be determined and compared with their rated capacities. This difference is due to the inability of the operating officials to get perfect results. This "personal equation" must be taken into consideration in figuring the number of trains per day with the new grades, as they will no more be able to get the best results under the new conditions than they were with the old. In making a reduction from a high rate to a low, for instance, from a 1% to a 0.3% or 0.4%, it must not be forgotten that the proportion of the actual loads to the theoretical rating will be lower on the low grades than on the high. Time is an essential factor. On a 1% grade in good weather, the actual loading may usually be made 90% of the theoretical, while on 0.3% it is unlikely that more than 75% of the rating can be hauled if time is to be made.

The proportionate amount of ruling grade on the Division has also an important bearing on the loading of trains, the greater the proportion its length bears to the length of the Division the lighter the actual train loads must be, and this too must be taken into consideration in determining the average number of trains per day required to handle the traffic on the proposed new grade.

Serious error would undoubtedly arise if the theoretical number of trains required to handle the traffic on the proposed new grade were compared with the actual trains on the present one.

While Fixed Charges—which are largely determined by the "Cost of Construction"—are of lesser consideration than Operating Expenses, they are still of prime importance. No road can pay dividends to stock holders, or afford to reduce freight rates until its Fixed Charges are met. So it is of the greatest importance that the engineer introduce no features that will increase the cost of construction without reducing the Operating Expenses by at least as great an amount as the interest on the added cost. The cost of moving a given tonnage being the sum of the Operating Expenses and the Fixed Charges—it follows that a reduction in the cost which does not increase the Operating Expenses is only of less importance than one which reduces the Operating Expenses without increasing the cost. Such a reduction in cost is a practical improvement to the standard of the road, as it increases the margin between receipts and expenditures, and so permits of an increase in dividends, or has a tendency to permit of a reduction in freight rates, if that be the object aimed at.

In Canada most of the new construction is through districts which at the time of completion furnish but little traffic: much railway has been built on which the traffic did not justify even one daily freight train per day each way. It is a safe statement that 80% of the mileage constructed in Canada would not furnish at the date of completion traffic sufficient for two freight trains each way per day. Under such conditions, the receipts are low and the Operating Expenses high, and it is of the utmost importance that the construction cost be kept low. On the other hand, the country is growing fast, and traffic is increasing rapidly. It is thus necessary that the engineer keep always in view the almost certain necessity of a good road in the future. He should, therefore, so locate and construct his line that the first cost be low, and that the standard may be raised, when necessary, without unduly increasing the total expenditure. In order to get the very best results, the line giving best grades, alignment, etc., should always be first located. From this, as a standard, the engineer should work to the final or economic location. Working from a poor to a better is apt to lead to grave errors.

Where low construction costs are necessary, and it is probable that a high standard will be required in the future, it is much more effective and advisable to use short sections of temporary line with steep grades, sharp curves, etc., on the heavy or difficult sections, maintaining the higher standard for the light or easy portions of line, than it is to adopt a generally lower standard for the whole route. The first cost of the former will probably be less; it may be operated with helper engines as the traffic increases, and may be improved when advisable, while the cost of improving a generally poor road is frequently prohibitive.

The use of sharp curves with short tangents is often a very effective means of reducing cost without materially increasing the Operating Expenses.

The effect of moderately sharp curvature is essentially different from steep grades, inasmuch as it is not limiting in its effect. The use of one sharp curve does not justify the use of another just as sharp—whereas the use of one ruling grade on a division does justify another as steep.

The use of curves up to 14 degrees does not increase the maintenance or operating expenses. A mile of road in which there are 100 degrees of 10 degree curve, the balance being tangent, does not cost any more to maintain and operate than the same length of road with 100 degrees of 2 degree curve—in fact, if there is any difference, it is in favor of the sharper curvature.

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

Unless the curvature is so sharp as to be limiting in its effect, there is no serious objection even on the best class of road to a few sharp curves where the amount saved by their use is sufficient to justify their introduction. The conditions which cause curves to be limiting are when they are so sharp as to prevent the use of the higher grades of modern equipment, and when they limit the haulage capacity of the locomotives, or their speed.

Modern equipment is so constructed as to traverse safely 14 degree curves, and much sharper with guard and hold up rails. The standard compensation for curvature on grades is 0.04 foot per degree. A 10 degree curve is thus equivalent, as far as resistance is concerned, to a 0.4% grade; and a 15 degree curve to a 0.6% grade. On a 0.4% it is only necessary that the grade on a 10 degree curve be made level in order that the resistance be not increased. The same thing applies to a 15 degree curve on a 0.6% grade. It is, therefore, evident that on a road whose ruling grades are 0.4% 10 degree curves are not limiting to the haulage capacity of the locomotives, nor are 15 degree curves on a 0.6% grade.

The easy riding speed is dependent on the amount of the allowable elevation of the outer rail. If the maximum be set at six inches, this speed per hour would be :—

on a 3 degree curve		60 miles per hour	
" 4	"	50	"
" 6	"	40	"
" 8	"	35	"
" 10	"	30	"

The safe or allowable speeds would be 10 miles per hour greater.

With the track properly elevated, equiped with tie plates kept in good line and surface, and curves provided with proper easements, 10 degree curves are no more disagreeable to ride over at speed of 30 miles per hour than are 3 degree curves at 60 miles per hour.

The reduction in speed for one mile from 50 to 30 miles per hour only means the loss of 0.8 minutes. To take an extreme case—the Twentieth Century Limited runs from New York to Chicago, 980 miles in 20 hours, or at an average of 49 miles per hour. The introduction of one hundred 10 degree curves each one of which required a slacking of speed to 30 miles per hour for a distance of one mile would increase the running time of such a train by one hour and twenty minutes. Such an increase on a road 1,000 miles long would in nine cases out of ten have no ill effect. A 10 degree curve so long as to require the reduction of speed to an average of 30 miles per hour for a mile would in practice be a very rare occurrence.

It is evident the use of curves as sharp as 10 degrees does not prohibit the employment of modern equipment or limit the haulage capacity of the locomotives. It has no effect on the speed of freight trains, or on passenger trains where the average speed including stops is not greater than 30 miles per hour. A few such curves only slightly affect the running time where speeds are high.

It is thus clear that a few curves not sharper than 10 degrees are not objectionable on the very best roads where their use results in large savings. As they are not limiting, the use of one such curve is no justification for a second. The introduction of many of them preventing the employment of high speeds for long distances would certainly be objectionable, but an occasional one where large savings result is justifiable on even the highest class of road.

Wooden trestles to replace heavy rock borrow embankments should be used. Such trestles may be designed to safely carry the heaviest class of equipment. When protected by the installation of the best available water supply they are quite safe, and are good for ten years. Such temporary construction also gives time to ascertain the correct requirements for water ways in new countries where there is frequently a dearth of information as to rainfall, flow of streams, &c., and where unless unduly large water ways are left there is danger of washouts. This danger may be even greater than the danger from fire to wooden trestles. Their use instead of heavy rock borrow embankments is of great importance from an economic point of view. One dollar at 5% compound interest amounts in ten years to $1.63. If rock borrow costs on the original construction say $1.75 per cubic yard it will in ten years time have amounted with interest to $2.85. While, under anything like ordinary conditions train hauled earth embankments on an operated road, made when the trestles require replacement, do not cost over 30 cents per cubic yard, or less than one-ninth of the total cost of a permanent rock embankment made during construction.

Momentum grades are a great source of saving in cost without increasing the operating expenses. The use of momentum in overcoming short stretches steeper than the ordinary ruling grade is almost always justifiable. The exception is where the traffic is so congested that the possibility of a delay due to the failure of an occasional train to surmount the grade is more important than the undoubted saving in interest charges which they insure. It will probably be many years before conditions prohibiting their use prevail on any portion of our Canadian railways.

The foregoing are a few of the more important considerations which the locating engineer should keep in view. He should always remember that railways are commercial enterprises, are built for profit, and that the investors are looking for and are entitled to satisfactory interest on their money; and so far as the returns on their investments depend on location they will for a given traffic be the greatest when the sum of the operating expenses and fixed charges is the least amount.

A NEW STREET CLEANER.

A new idea in street sweeping by machinery has recently been introduced into England, having been used for some time previously in Milan, the inventor of the machine being an Italian. About the middle of December one of these machines was demonstrated before a number of municipal engineers and other officials from several English cities, picking up satisfactorily the customary assortment of sand, straw, small stones, etc., which are ordinarily scattered for tests of this kind. The machine is propelled and operated by a 20-30 h.p. 4-cylinder motor. Aside from the motor, it consists of a revolving broom carried between the fore and hind wheels, and a double dirt receiver which is carried behind the rear wheels. The revolving cylindrical broom has a diameter of 52½ inches, is 5 feet long, and is built up of twenty distinct small piassava brushes, each five feet in length, arranged along parallel elements of the cylindrical core of the brush.

The cylindrical broom revolves within a sheet iron shell in which it fits closely, at a speed of 120 revolutions per minute; which results in its not only raising the sweepings and carrying them two-thirds of a revolution and passing them through a specially contrived opening into the receivers behind, but the circumferential speed of the broom is said to create a sufficient suction in the cylinder to draw in all the dust and discharge it likewise into the receivers. It is also claimed that the velocity with which the broom revolves throws the refuse into the receivers with such force as to compress it and thus make the capacity of the receiver greater than if the dust merely settled in it.

The rear end of the compartment of the car which contains the two dust receivers is made in the shape of a large door hinged at the bottom which, when opened, forms an incline platform down which the filled boxes are rolled to the ground, each box being furnished with three small wheels or castors. The receivers or collecting boxes are of sheet iron and have a capacity of 50 cubic feet.

The total weight of the car with the receivers empty is 6,450 lbs. It is claimed that the cost per hundred thousand square feet of cleaning with this machine was $1.86, as compared with $11.18 with horse sweepers.

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

REPORT OF THE COMMITTEE ON CONSERVATION OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The field of conservation, so far as it affects the engineering profession, is so vast that it was deemed inexpedient to deal with more than one phase of it. At the last annual meeting a communication from Mr. Sauder was addressed to the Society and, later, referred to the Committee on Conservation. Mr. Sauder wrote:

"Whereas the water supplies, water powers, navigation of our "rivers, irrigation of our semi-arid lands, drainage of our over-flow "and swamp lands and the sanitary conditions of our streams and "their water sheds generally are a great asset.

"Whereas an accurate knowledge of a flow of water in nearly "all important streams is essential for the solution of many problems "in connection with navigation, water power, irrigation, domestic "and industrial water supplies, mining, bridge building, river channel "protection, flood prevention and storage for conservation of flood "waters.

"Whereas it is the opinion of the Society that the matter of the "topographical and hydrographic surveys to determine the location "and quantity of water supply and the proper methods of conserving "it should be undertaken by the Federal Government.

"Therefore be it resolved: That this Society, while recognizing "the work already done, urges strongly upon the Dominion Govern-"ment the importance of making the necessary appropriations and "providing the necessary staff to undertake in an intelligent and sys-"tematic manner, the gauging of all streams of water supply and the "location and survey of all sites suitable for reservoirs for the storage "of water."

This letter was referred to the members of the Committee and the concluding statements of the report embody the substance of the replies received from them. In view, however, of the importance of the subject it was deemed advisable to take this subject—Water Supply and its Conservation in Canada—as the special subject for this year's report.

When planning to develop a water power or a navigation channel, the first consideration is: What is the minimum flow? The speed of a squadron is the speed of the slowest vessel and, speaking generally, the minimum flow is a determining factor in a water-power or a navigation project. The minimum flow may often be increased by storage in reservoirs but the initial step is to determine its amount and the maximum period that it may be expected to continue.

In arriving at anything approaching a reliable estimate of the minimum flow of a stream, a series of continuous gaugings extending over a considerable period is absolutely necessary. George W. Rafter, in Water Supply Paper No. 80, published by the U.S. Geological Survey, says:

"Further, it can be stated that, for records from twenty years "to thirty-five years in length, the error may be expected to vary "from 3.25 per cent. down to 2 per cent., and that, for the shorter "periods of five, ten and fifteen years, the probable extreme devi-"ation from the mean would be 15 per cent., 8.25 per cent. and "4.75 per cent. respectively."

Rafter says, further, that with less complete records,

"Mr. Henry reached the conclusion that at least 35 to 40 years' "observations are required to obtain a result that will not depart "more than $\pm$ 5 per cent. from the true normal. The average vari-"ation of a 35-year period was found to be $\pm$ 5 per cent. and for a "40-year period $\pm$ 3 per cent."

From the foregoing, it is evident that unless the engineer is in a position to allow a margin on the safe side, he should have continuous gaugings extending over at least ten years. As an example of an erroneous estimate based on insufficient data, the Rainy River at Fort Frances may be cited. Three engineers, reporting separately, estimated the power at 30,800, 33,000 and 34,741 horse power respectively. In the summer of 1911, they were able to generate less than 11,000, and, to do this, it was necessary to keep the stop-logs in all day Sunday, thus stopping navigation. Had gaugings extending over, say ten years, been available, no such over-estimates would have been made and, had they included the very dry season of 1895, they would, probably, have shown as small a flow as in 1911.

Canada is particularly favoured as regards reservoir possibilities. The whole of the northern portion of the Dominion is occupied by a series of granitic rocks, which have a U-shaped form and surround Hudson Bay. This area has been called the Archaean nucleus and, considered in the large, it forms a great plateau. To quote the words of the late Dr. G. M. Dawson,

"It constitutes, moreover, a gathering ground for many large "and almost innumerable small rivers and streams, which, in the "sources of power they offer in their descent to the lower levels, are "likely to prove, in the near future, of greater and more permanent "value to the industries of the country than a great coal-field"

The foregoing was written sixteen years ago, and, with the tremendous strides in electrical engineering, is even truer to-day than then.

The most remarkable features of this Laurentian area are the innumerable lakes which serve as natural reservoirs to regulate the run-off and which can, in many cases, have their storage capacity increased by damming.

In considering the work of stream-gauging in Canada, the provinces have been dealt with in geographical order from East to West.

In the Maritime Provinces, the streams are small and very little gauging has been done except on the St. John River and some of its tributaries. The work on the St. John has been undertaken as a result of differences between Canada and the United States respecting the provisions of the Ashburton Treaty affecting this stream. The St. John above the Allagash and at Fort Kent, the Allagash, St. Francis, Fish, Madawaska and Aroostoock have been gauged. Measurements have also been taken on the St. Croix River which forms the Southern boundary between New Brunswick and Maine. So far as ascertainable, nothing has been done in the way of investigating sites for reservoirs except the reconnaissance surveys made by the Commission of Conservation in 1911.

In Quebec, the more important power companies keep records of the streams on which they are operating. Between lake St. Francis and Sorel, the Department of Public Works has at present nine gauges. Two of these gauges are of the self-recording type and four others of the same type will be in operation next summer.

The Department of Public Works has sixteen gauges on the Ottawa River, and also maintains gauges on its important tributaries. The Engineers of the Georgian Bay Ship Canal, appreciating the importance of stream measurements, made in their report the following recommendation:

"That it is of great importance to continue every year the flow "measurement of the Ottawa, Mattawa and French Rivers, at low, "ordinary and high water stage, in order to have continuous records "of same, which will prove invaluable in the further development "of the canal problem, in case of construction, and a better knowledge "of the water-power possibilities."

On the Richelieu River, the depths on the lock sills of the Chambly canal, at St. Johns, have been recorded daily since 1869 and the level of lake Champlain has been noted daily at Fort Montgomery, N.Y. since 1871. At Montreal, the depths of water on the lower lock sill of the Lachine canal have been measured at noon each day since 1851.

The Province of Quebec has appointed a Commission with the Hon S. N. Parent, as Chairman. They have recommended the construction of a large dam on the upper waters of the St. Maurice to regulate the flow and have three parties in the field making topographical and hydrographic surveys of various rivers in the Province.

On the St. Lawrence above Montreal the depths on the lock sills have been recorded since 1860. These, therefore, give an excellent series of gauge readings for the river at lake St. Louis, lake St. Francis, Long Sault rapids, Farrans Point, Morrisburg and Cardinal. Similarly, the canal records at Ste. Anne, Carillon and Grenville determine the regimen of the Ottawa since 1870, while the lock depths at Ottawa extend back to 1844. For lakes Superior, Huron and Erie, the records cover the period since 1860, while the Toronto gauge records of lake Ontario extend back to 1854.

In the western portion of Ontario the Departments of the Interior and Public Works have established one gauge on Rainy Lake and five on Rainy River. Next summer five of them will be replaced by self-reading gauges. In connection with the investigation of the water-levels of the Lake of the Woods, the International Joint Commission will establish others on the upper waters of the Rainy River.

So far as work by provincial governments is concerned, Ontario is much the most advanced. Its Hydro-Electric Power Commission has established gauging stations on a great many of the streams of the province and is carrying on the work of stream-gauging in a thorough and systematic manner; possibly the only improvement in this connection would be the establishment of additional stations until all the streams of importance are included in the work.

The powers conferred upon the Commission in this connection may be described as follows:

"It is duly authorized to investigate and report to the Lieutenant-Governor-in-Council upon any and all hydraulic, hydro-electric and other power undertakings, whether developed or undeveloped, throughout the Province."

In connection with the waterpowers of the Winnipeg River, the Water Powers Branch of the Department of the Interior has investigated the water resources of the Lake of the Woods drainage basin. In conjunction with the Department of Public Works, gauging stations have been established on Rainy River and certain important streams falling into Rainy Lake and a study has been made of the outflow from the Lake of the Woods.

While in the Maritime Provinces, Quebec, Ontario and British Columbia, except the Railway Belt and Peace River Block, the water powers are disposed of and are under provincial jurisdiction, in the Prairie Provinces, Manitoba, Saskatchewan and Alberta, they are under the control of the Dominion Government. This right was reserved when the provinces were created with a view of better conserving their waters as a whole and for this purpose a large forest area on the eastern slope of the Rocky Mountains has, recently, been segregated by the Dominion.

In Manitoba, the Water Powers Branch of the Department of the Interior has established stations on the more important rivers where information is required in connection with waterpowers, drainage, navigation, etc. The work is being gradually extended over the whole province to meet the economic conditions.

The Dominion Government has, for some time past, made investigations of the flow of streams in the latter provinces and, although these investigations were more particularly for irrigation purposes, they also have an indirect bearing on waterpowers. The following is an extract from one of the reports on this work:

"The records of stream flow published by the Irrigation Surveys give a fair approximation of the discharge of the principal streams in Southern Alberta and Saskatchewan at the different stages, but do not give the duration of the periods of high and flood discharge. As the water supply in some of the larger streams is apparently almost all recorded, the necessity of carrying on a systematic observance of daily discharge is evident.

"The chief features of the hydrographic work are the collection of data relating to the flow of the surface waters and the conditions affecting this flow. Information is also collected concerning the river profiles, duration and magnitude of floods, waterpower, etc., which may be of use in hydrographic studies."

"In organizing the Hydrographic Surveys it was realized that with the funds available, it would be impossible to make complete investigations of the whole of the water supply in the irrigation tract, but an effort was made to include all the more important streams. Gauging stations had already been established, by the Irrigation Surveys, on a number of the more important streams, and it was important that the observations at these should be continued without interruption. There were, however, many streams of considerable importance upon which there were no gauging stations. It therefore became the policy of the survey to continue the investigations at the stations already established and to establish other stations as soon as possible."

Unfortunately, as the work is being pursued in connection with irrigation, it does not include any figures for the winter season, which additional data would be of great value from a waterpower standpoint; this is recognized in the following quotation also from the report above cited:

"On streams where power is likely to be developed, special attention should be given to the low water flow, which in most cases occurs during the winter. For this reason it is very important that stream measurements should be continued during the winter on a number of the more important streams."

In British Columbia, the Water Powers Branch has a permanent organization known as the Railway Belt Survey. Gauging stations have been established on the important water-power rivers in the Railway Belt and special attention has been given to the streams in the so-called "Dry Belt."

During 1911 and 1912, the Commission of Conservation made reconnaissance surveys of water-powers in southern and central British Columbia and this work will be continued. In 1912, the Department of Lands of British Columbia, recognising the value of this work, appropriated nearly $2,500.00 in addition to the amount expended by the Commission of Conservation and will, this year, make a grant of $5,000.00. This work, however, is only in the nature of a reconnaissance and, wherever the development of the country indicates that the water will be economically usable, it should be followed up by such measurements as the Water Powers Branch of the Department of the Interior is now carrying on.

The great importance of systematic stream gauging in Canada cannot be over estimated. On the information furnished by the Government will depend to a great extent the development of water-power. Very often, before designing a development, the hydraulic engineer has to spend a year or more in making observations which in many cases are practically useless, because they do not cover a sufficiently long period, and the result is that the possible development is either much over-estimated or, in other cases, much under-estimated.

Although most of the waters of Canada are under provincial control, this matter of stream gauging is not only important to the different provinces but it is of national importance, and the Federal authorities should undertake the gauging of Interprovincial and International rivers to collect this all-important data in a systematic and uniform manner.

The Provincial Governments could make a beginning by devoting their attention altogether to the establishment of stations where the water levels only would be read, leaving, if necessary, for future years the systematic observations required to convert these water heights to discharges. It was in this manner that it has been possible to calculate the different discharges of the Ottawa River since 1844: water-levels only had been kept since that date by the lockmasters of the canal at Ottawa and it was only comparatively recently that observations were taken to convert these water-levels into actual discharges.

For the present, of course, it would be out of the question to have these stations on all of our streams, but a start might be made on the more accessible ones or those on which storage and conservation will become a necessity or a natural outcome at some future date. At present, there are very few streams in Canada on which artificial storage or conservation is being practised, because it has not yet become commercially economical or necessary to do so. When the power possibilities of a stream under natural flow have been exhausted at one site, other sites, nearby, on the same or other streams have been found and developed, this requiring less outlay per h.p. than would have been required to conserve the flow of the stream. But this cannot go on forever, and a time will come when the last site within an economical radius will have been secured and the conservation of the stream will have to be resorted to in order to satisfy the increasing demand for power. When this time comes, in order to develop a conservation scheme on any stream intelligently, it will be necessary to possess a complete history of the flow of the stream under consideration for a period of at least from ten to fifteen years previous, and, unless a beginning is made now on the history of flow of some of these streams, when the time comes to conserve them the data at

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

hand will be found very meagre and the conservation scheme will have to be designed in a more or less haphazard manner.

With federal co-operation, the system now practised in Ontario could probably be continued and extended to comprise other streams and establish new stations more rapidly.

In Quebec and the Maritime provinces, much data on this subject could no doubt, first of all, be collected from private parties or large hydraulic plants where records of river heights have been kept, and a system similar to that of Ontario or a modification to suit local conditions could be started at once and the returns from the different stations throughout Canada sent to their provincial authorities as well as to Ottawa, where they could be tabulated in a uniform manner and printed for easy access to the public.

Other countries with less water-power possibilities than Canada have devoted a great deal of attention to systematic observation of stream flow, namely: Italy, Switzerland, Bavaria France and other European countries. In the United States, the Geological Survey has, for years, devoted a great deal of attention to the subject of stream measurement and has developed an excellent system, both of carrying out the work in the field and of reporting and tabulating the data obtained.

In Canada, one of the greatest difficulties to be overcome in connection with this work is the taking of observations during the winter season, as practically all our streams are then frozen over. These difficulties, however, can be overcome and they are always more than balanced by the importance of obtaining complete and reliable data during the very time when the rivers are in this condition.

In a report on "Stream Flow during the Frozen Season," Messrs. H. K. Barrows and R. E. Horton of the U.S. Geological Survey say in part—"There is not even an approximate relation between the snow-fall and the stream flow, so that the failure to obtain winter records of flow at a gauging station means a considerable percentage of uncertainty as to the total run-off as well as its distribution. In the Northern states droughts are apt to occur in the late summer or fall and during the winter. At times this condition of drought may be nearly or quite continuous between these two periods, with its culmination in January or February. If there is no melting of snow during the winter, the inflow to streams that freeze is chiefly derived from springs, ground water, and lake storage and in a long, cold winter, especially if it succeeds a period of low water, the minimum flow for the year may be reached and continue for some time. Estimates of flow, therefore, to be of conclusive value on streams utilized for water-power, must embrace these winter periods of low water."

It is needless to add that the winter conditions which occur in Northern United States rivers are found even in a more marked degree in Canadian rivers, and it follows that the statement just quoted applies with a proportionately greater force to Canada.

Summing up, the Committee on Conservation is of the opinion that, while the work recommended by Mr. Sauder, viz., topographical and hydrographical surveys to determine the situation and quantity of water supply, should be undertaken by the Dominion Government, and is of great importance, it is probable that the Government is, at the present time, carrying on more extensive and detailed investigations of this nature than is generally appreciated. That, while a certain amount of concentration to avoid duplication and overlapping of work is necessary, the scale upon which the work has been initiated indicates that the needs of the country in this respect will be met.

That the work already done is of great value but that much of it is not, in its present form, available to the engineers and

That steps should be taken to secure such publication and distributiou of this information as will bring it within the reach of each and every engineer in Canada.

COMMITTEE—

James White, Chairman.
H. F. Laurence.
R. McColl.
R. O. Sweezey.
W. H. Breithaupt.
G. A. Bayne.
A. J. MacPherson.
J. S. Dennis.
J. B. Hegan.
C. E. W. Dodwell.
A. E. Doucet.
R. S. Lea.
R. W. Leonard.
E. E. Brydone-Jack.
W. R. W. Parsons.
John Chalmers.
T. H. Tracey.

JAMES WHITE
Chairman

REPORT ON THE VISIT OF MEMBERS OF THE INTERNATIONAL CONGRESS OF NAVIGATION TO CANADA IN JUNE, 1912.

On March 6th, 1912, Col. W. P. Anderson, Chief Engineer of the Department of Marine and Fisheries, acting for the Department, addressed the Council of the Society to the effect that the members of the International Congress of Navigation had been invited by the Canadian Government to visit Canada on the conclusion of the sessions of the Congress to be held in Philadelphia in May, 1912. Col. Anderson intimated that the Dominion Government had voted $20,000 to provide for the expenses of the delegates and that of this sum $5,000 would be required for the necessary official publications, the remaining $15,000 being available f r transportation and incidental charges. He also stated that Major G. W. Stephens, Chairman of the Montreal Harbour Commission, who had been officially nominated by the Government to represent Canada at the Congress, had recommended that the Canadian Society of Civil Engineers should be invited to organize the proposed visit to Canada, and asked if the Council would be willing to undertake the work of outlining a programme and make the necessary arrangements for carrying out the excursion.

At a meeting held on March 9th the Council acquiesced in the proposal and appointed a Committee consisting of Messrs. H. Holgate and H. H. Vaughan, Vice-Presidents of the Society; Mr. Ernest Marceau, Past President; Messrs. C. N. Monsarrat, J. N. Shanly, W. J. Stewart and P. E. Parent, Members of Council; Mr. A. St. Laurent, Department of Public Works, Ottawa; and Professor C. H. McLeod, Secretary of the Society, to confer with Major Stephens and report. This Committee met Major Stephens, and as a result of various conferences with him and with the Department of Marine and Fisheries through Col. Anderson, the following programme was outlined and received the approval of the Council of the Society and of the Department of Marine and Fisheries on behalf of the Government of Canada. It was understood that the Society, represented by its Council and special Committee, would act for the Government in receiving the foreign guests and conducting them to the various places named and works of engineering and commercial interest of the Dominion. It was further arranged that in addition to the central Committee of the Council above mentioned, the Society's Branches at Toronto and Ottawa should be asked to formulate the programmes in these cities and be responsible for the completion of the same. In Ottawa the departmental officials were to take in hand, especially, the organization of the banquet to be tendered to the delegates by the Dominion Cabinet.

CANADIAN EXCURSION

June 12th P.M.—Leave Sault Ste. Marie.

June 13th A.M.—Arrive Port McNicoll.
The terminal facilities of this Port will be inspected and a special train will convey the party to Toronto.
P.M.—Arrive Toronto.
The afternoon will be spent in sight-seeing.

June 14th A.M.—A short excursion on the Lake and Harbour.
The Toronto programme will be in charge of a local Committee of the Toronto Branch of the Canadian Society of Civil Engineers.
P.M.—Leave Toronto (by steamer).

June 15th A.M.—Arrive Prescott.
Before reaching Prescott (about 10 A.M.) the Thousand Islands of the St. Lawrence River will have been passed through.
A.M.—Leave Prescott.
P.M.—Arrive Ottawa.
The arrangements at Ottawa will be in charge of a Committee of the Ottawa Branch of the Canadian Society of Civil Engineers. A very interesting programme has been prepared, including a banquet to the gentlemen of the party by the Dominion Cabinet, and some special entertainment for the ladies.

June 16th A.M.—Leave Ottawa (by train).
A.M.—Leave Coteau Landing (by boat).
P.M.—Arrive Montreal.
On this trip the lower lock of the Soulanges Canal will be inspected.
June 17th —At Montreal—Inspection of Harbour and tour of City.
June 18th A.M.—Leave Montreal by Government Steamer.
P.M.—Arrive Quebec.

The Council at a subsequent meeting appointed Professor McLeod as the representative of the Society to the Congress in Philadelphia, in order chiefly that he might have an opportunity of ascertaining the names and becoming acquainted with those members who desired to visit Canada and of organising the various features of the excursion in Canada.

Immediately on the adoption of the programme, transportation arrangements were made with the C. P. Ry. Co., the R. & O. Navigation Company and the G. T. Ry. and with the Department of Marine and Fisheries for the use of a special steamer from Montreal to Quebec, and the necessary hotel accommodation was reserved at Toronto, Ottawa, Montreal and Quebec. The following is the list of those who registered at Philadelphia for the Canadian Excursion.

Representing the Argentine Republic

Mr. Figueroa, O., Civil Engineer, London, Government Delegate.

Representing Belgium

Mr. Vander Vin, H., Chief Engineer of Bridges and Roads, Antwerp, Government Delegate.
Mr. Bogaert, M., Engineer, Brussels.
Mr. Bonnel, J., Builder, Brussels.
Mr. Bosquet, Albert, Brussels.
Mr. Bosquet, J., Brussels.
Mr. Cleuren, G., Brussels.
Mr. Colin, E., Brussels.
Mr. Colin, E., Jr., Brussels.
Mr. de Beukelaer, F., Merchant, Brussels.
Mr. de Koninck, L., Brussels.
Mr. Delbove, L., Brussels.
Mr. de Meulenaere, O., Brussels.
Mr. Dillies, C., Manufacturer, Brussels.
Mr. Fichelin, G., Brussels.
Mr. Medaets, A., Contractor of Public Works, Brussels.
Mr. Mertens, Chas., Clerk of Bridges, etc., Brussels.
Mr. Piron, Expert, Brussels.
Mr. Van der Houte, J. F., Contractor.
Mr. Vandeuren, J., Contractor, Brussels.
Mr. Verganwen, Brussels.

Representing Brazil

Dr. M. E. de Souza Bandeira, Government Delegate.
Miss Marie de Souza Bandeira.

Representing Canada

Lt.-Col. Anderson, W. P., Chief Engineer, Dept. of Marine, Ottawa, Government Delegate.
Mr. Lamb, H. J., Engineer of Public Works, Windsor, Government Delegate.
Mr. McLeod, C. H., Professor, Montreal, Corporation Delegate.
Mr. de Bray, Dr. of Science, Montreal.
Mrs. Anderson, Ottawa.
Mrs. de Bray, Montreal.

Representing Cuba

Mr. Guastella, S., Chief Engineer, Havana, Corporation Delegate.

Representing Denmark

Mr. Hummel, C. M., Chief Marine Engineer, Copenhagen, Government Delegate.
Mr. Schonweller, G., Prof. i. Wasserbau, Copenhagen.

Representing Egypt

Mr. d'Epantchine, N., Engineer, Cairo.

Representing France.

Mr. Chargueraud, State Councillor, General Inspector of Bridges and Roads, Paris, Government Delegate.
Mr. de Joly, G., Chief Engineer of Bridges and Roads, Paris, Government Delegate.
Mr. Barrillon, P., Engineer of Bridges and Roads, Bordeaux, Government Delegate.
Mr. Bouvaist, General Inspector of Bridges and Roads, Government Delegate.
Mr. de Pulligny, Chief Engineer of Bridges and Roads, New York, U.S., Government Delegate.
Mr. Voisin, J., Chief Engineer of Bridges and Roads, Boulogne sur Mer, Government Delegate.
Mr. Batard-Razeliere, A., Chief Engineer of Bridges and Roads, Marseilles, Government Delegate.
Mr. Ducrocq, Chief Engineer of Bridges and Roads, Le Havre, Government Delegate.
Mr. Dreyfus, S., Chief Engineer of Bridges and Roads, Paris, Government Delegate.
Mr. Le Trocquer, Engineer of Bridges and Roads, Paris, Government Delegate.
Mr. Perrier, L. C., Chief Engineer of Bridges and Roads, Ismailia, Egypt, Government Delegate.
Mr. Farjon, F., President, Chamber of Commerce, Boulogne sur Mer, Government Delegate.
Mr. Brancher, A., Engineer, Paris.
Mr. Narcy, P. J., Notary, Le Havre.
Mrs. Voisin, Boulogne sur Mer.

Representing Germany

Dr. Freiherr von Coels von der Brugghen, Under Secretary of State, Public Works Dept., Berlin, Government Delegate.
Mr. Lusensky, F., Ministerial Director for Trade and Commerce, Berlin, Government Delegate.
Mr. Tincauzer, E., "Geheimer Oberbaurat," Public Works Dept., Berlin, Government Delegate.
Mr. Thoholte, R., "Geheimer Baurat," Dept. of Lands and Forests, Berlin, Government Delegate.
Mr. de Thierry, G., "Geheimer Baurat" and Professor, Berlin, Government Delegate.
Mr. Hedde, P., Kais. Marine Architect, Berlin, Government Delegate.
Mr. von Haag, Ph., Ministerial Director, Dept. of the Interior, Stuttgart, Government Delegate.
Mr. Ehlers, P., Member of Board of Works and Professor, Danzig, Government Delegate.
Mr. Schulze, F. W. O., Professor, Danzig, Government Delegate.
Mr. Wulle, K., Government Architect, Dirschau, Government Delegate.
Mr. Frentzen, K., Government Architect, Dorsten (Lippe), Government Delegate.
Mr. Gugenham, M., "Oberbaurat," Stuttgart, Government Delegate.
Mr. Mayburg, Government Architect, Dusseldorf, Government Delegate.
Mr. Apelt, President, Chamber of Commerce, Bremen, Corporation Delegate.
Mr. Hoffmann, A., Editor, Leipzig, Corporation Delegate.

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

Mr. Schmidt, G. H., Harbour Director, Dortmund, Corporation Delegate.
Mr. Brinzinger, A., Architect, Esslingen.
Mr. Bueren, H., Merchant, Munster.
Mr. Ebelt, O., Government Architect, Essen-Ruhr.
Mr. Heiser, B., Government Architect, Pillau-Konigsberg.
Mr. Jungel, J., Government Assessor, Stuttgart.
Mr. Landsberg, G., Government Architect, Berlin
Mr. Lehmann, F., Member Municipal Board of Works, Osnabruck.
Mr. Lisse, L., "K. Bergassessor," Charlottenburg.
Mr. Lobbecke, E., Doctor of Law, Hildesheim.
Mr. Meck, B., Manufacturer, Nurnberg.
Mr. Schinkel, M., Government Architect, Kiel.
Mr. Speer, T., Assessor, Heilbronn.
Dr. Zimmerman, E. W., New York.
Mrs. Else Landsberg, Berlin.
Mrs. Schmidt, G., Dortmund.
Mrs. Thoholte, Berlin-Steglitz.

REPRESENTING GREAT BRITAIN

Lt.-Col. Yorke, H. A., R.E., C.B., London.
Mrs. H. A. Yorke, London.

REPRESENTING HUNGARY

Mr. de Kohanyi, Z., Chief Marine Inspector, Budapest, Government Delegate.
Mr. Posa, Chas., Technical Adviser, Budapest, Government Delegate.
Mr. de Szabo, N., Chief Engineer, Budapest, Government Delegate.

REPRESENTING ITALY

Mr. Sandjust di Teulada, E., Chief Civil Eng. Inspector, Rome. Government Delegate.
Mr. Luiggi, L., Chief Civil Eng. Inspector, Rome, Government Delegate
Mr. Valentini, C., Chief Civil Engineer, Bologna, Government Delegate.
Mr. Dondonna, Ph.. Naval Captain, Pittsburgh, U.S., Government Delegate.
Mr. Brunati, P., Engineer, Milan.
Mr. Castiglioni, C., Engineer, Milan.
Mr. de Chantal, E., Engineer, Venice.
Mr. Fontana, P., Engineer, Milan.
Mr. Gullini, A., Engineer, Rome.
Mr. Pain, A., Engineer, Venice.
Mr. Rava, G., Engineer, Venice.
Mr. Allegri, M., Army Doctor, Venice, Corporation Delegate.
Mr. Vianello, F., Naval Captain, Venice.
Mrs. Allegri, Venice.

REPRESENTING MEXICO

Mr. Mateos, J., Mexican Consul, Port Arthur, Texas, Government Delegate.

REPRESENTING NORWAY

Mr. Kristensen, I., Director of Maritime Works, Kristiania, Government Delegate.
Mr. Johnsen, J. P., Kristiania.

REPRESENTING ROUMANIA

Mr. Botez, E., Naval Captain, Soulina.

REPRESENTING RUSSIA

Mr. de Timonoff, V. E., Engr., State Councillor, St. Petersburg, Government Delegate.
Mr. de Hoerschelmann, E. F., Engr., State Councillor, Tsarskoie Selo Government Delegate.
Mr. Merczyng, C. K., Engr., State Councillor, St. Petersburg, Government Delegate.
Mr. Tsionglinsky, M. F., Engr., State Councillor, St. Petersburg Government Delegate.
Mr. de Rummel, L., State Councillor, Reval, Government Delegate.
Mr. Olkhine, A. S., State Councillor, Director of Commerce, Government Delegate.
Mr. Ivanovsky, A. V., Engineer, Government Delegate.
Mr. Bakhmetief, J. A., State Councillor, Government Delegate.
Mr. Rojdestvensky, A. K., Engineer, Government Delegate.
Mr. Chovgenoff, Court Councillor, Government Delegate.
Mr. Kortschynsky, Engineer, Moscow.
Mr. Laknisky, V. E., Engineer, St. Petersburg.
Mr. Martinowsky, M., Engineer, Cherson.
Mr. Schmakoff, W., Moscow.
Mr. Zwetaieff, Moscow.
Miss Kortschynsky, Moscow.

REPRESENTING SWITZERLAND

Mr. Hilgard, K. S., Prof. Consulting Engineer, Zurich. Corporation Delegate.

REPRESENTING THE UNITED STATES

Lt.-Col. Sanford, J. C., Corps of Engineers, Philadelphia, Government Delegate.
Col. White, H. K., U.S. Marine Corps, Southport.
Mrs. J. C. Sanford, Philadelphia.
Mrs. H. K. White, Southport.

The meetings of Congress were concluded on May 28th, and a large number of the delegates made a trip to Washington, Pittsburg and other Southern points and returning, one party by way of Hudson River, the other through Cape Cod and Boston, united at Albany whence an excursion was made along the line of the New York State barge canal with stops at Syracuse and Buffalo. At Buffalo, the party, numbering about three hundred, embarked on the steamer "Northland" and visited Cleveland, Detroit and Sault Ste. Marie. At Sault Ste. Marie the Canadian party separated from the other excursionists and began the trip in accordance with the above programme.

The following members of the Canadian Society of Civil Engineers welcomed and took charge of the foreign visitors:—Col. Anderson, Past President of the Society; Dr. J. Galbraith, Past President of the Society; Mr. J. Morkill, Member of Council; Mr. H. J. Lamb, Member; and Mr. C. H. McLeod, Secretary. On account of various unforeseen causes several of the gentlemen, who had booked passage at Philadelphia, were unable to make the Canadian excursion, and it was especially regretted that amongst these was Professor de Timonoff, the President of the Congress. Some time was spent at Sault Ste. Marie examining the locks and shipping facilities on the American and Canadian sides, and the voyage down the Lake and Georgian Bay commenced at 3 P.M., Wednesday, June 12th.

Messrs. J. G. Sing and T. R. Loudon, representing the Toronto Branch of the Canadian Society of Civil Engineers, came to Port McNicol for the purpose of distributing hotel assignments and making other arrangements with the managers of the Excursion. At Toronto the party was welcomed by the Committee of the Toronto Branch of the Society named below, and under their direction the following local programme was carried out in a most successful manner.

TORONTO COMMITTEE

Chairman—T. C. Irving, Jr.
Secretary—T. R. Loudon
G. G. Powell
H. E. T. Haultain

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

J. Galbraith
E. T. J. Brandon
Parker Kemble
F. F. Loudley
Allan Garrow
E. L. Cousins
J. G. Sing

The special thanks of the Society are also due to the Mayor of Toronto, Mr. Reginald Geary, to Commodore Aemilius Jarvis of the R.C.Y. Club, and to Mr. L. H. Clarke, Chairman of the Harbour Commissioners. The following gentlemen also contributed in a wholehearted manner toward the success of the visit to Toronto: Messrs. E. L. Cousins, Engineer of the Harbour Board; A. L. Lewis, Secretary of the Harbour Board; J. C. Eaton, whose magnificent yacht was put at the disposal of the visitors; Alderman Alf. Maguire, who was associated with the Mayor in representing the City; Lt.-Col. J. B. Miller, Mr. Carl Allen of the R.C.Y. Club, and others for many courtesies. The ladies of the party were entertained under the direction of the following Committee:

Mrs. Galbraith	Mrs. Cousins
Mrs. Kemble	Mrs. Loudon
Mrs. Sing	

TORONTO PROGRAMME

"Special train is due to arrive Toronto about 1.15. Party will detrain at North Parkdale station, and take special street cars waiting on Dufferin Street which will run direct to King Edward Hotel. Headquarters of the party will be King Edward Hotel.

Tickets will be found herewith showing room assigned to each member of the party. Please present these tickets at King Edward Office for keys.

Baggage will continue by train to Union Station and will be conveyed from there to the hotel. Each piece of baggage should have a tag attached showing room number of owner at King Edward Hotel.

Luncheon will be served at King Edward Hotel at 1 30 and ticket for same will be found herewith

Through the courtesy of the Toronto Board of Harbour Commissioners, and the Commodore and Members of the Royal Canadian Yacht Club, the party will be tendered a trip around Toronto Island. The Royal Canadian Yacht Club's launch leaves the R.C.Y.C's. city station at the extreme end of the East side of Yonge Street dock at 2.45, 3 15 and 3.45, for the R C.Y.C. Club House, Toronto Island where the yachts will be boarded

At 7 o'clock a Dinner will be tendered by the Harbour Commissioners and the Royal Canadian Yacht Club in the Club House, Toronto Island. Dress will be informal.

Friday, June 14th. A breakfast ticket will be found herewith.

At a quarter to ten, through the courtesy of the City Council and a number of Citizens of Toronto, automobiles will be placed at the disposal of the visitors for a ride around the city. The party will leave the King Edward Hotel sharp at 10 o'clock and will proceed to the City Hall, where His Worship, the Mayor, will receive the party in the Council Chamber, after which automobiles will be taken for a drive, visiting points of interest, including the Provincial Parliament Buildings and the University of Toronto. The drive will terminate at McConkey's where a luncheon will be tendered by the City Council.

Richelieu and Ontario Navigation Co's. boat leaves the East side of the foot of Yonge Street sharp at 2.30, and the members of the party should be on board not later than 2 15. All baggage should be ready not later than 12 o'clock noon and each piece should have a ticket showing the number of the owner's stateroom on the R. & O. boat."

Passage was taken from Toronto at 2 30 p.m., on Friday, June 14th, on the S.S. Kingston. It was, unfortunately, necessary for several of the members, on account of their business arrangements and dates of sailing from New York to leave the party at Toronto. Those on board the steamer numbered in all 131 The party landed at Prescott early on Saturday morning, where they were met by Mr. D. MacPherson, Member of Council, representing the Ottawa Branch of the Society. At Ottawa the delegates were received by the following Committee, under whose direction the local programme outlined below was observed.

OTTAWA COMMITTEE

Chairman—S. J. Chapleau
Hon. Secy.-Treas.—H. V. Brayley,
Noulan Cauchon
R. de B. Corriveau
F. J. Delaute
John Murphy
R. F. Uniacke

The Ottawa banquet was given in the new and magnificent Chateau Laurier Hotel and was presided over by Mr. Hazen, Minister of Marine and Fisheries. The following Cabinet Ministers were also present, adding thereby eclat to the occasion.

Col. Hon. Sam Hughes, Minister of Militia and Defence.
Hon. C. J. Doherty, Minister of Justice.
Hon. Martin Burrell, Minister of Agriculture.
Hon. F. D. Monk, Minister of Public Works.
Hon. T. W. Crothers, Minister of Labour.
Hon. G. H. Perley, Minister without portfolio.
Hon. J. A. Lougheed, Minister without portfolio.

OTTAWA PROGRAMME

"The visiting members will arrive at the Central Station at noon. They will be met by representatives of the Ottawa Branch, Canadian Society of Civil Engineers.

Informal Lunch will be served at the Chateau Laurier.

During the afternoon, automobiles will convey the party, accompanied by members and ladies of the Ottawa Branch, through picturesque Ottawa, and the following itinerary, so far as possible, will be followed:—

2.15 P.M.—Leave Chateau Laurier for Parliament Hill. Attention is directed to: (1) The Locks of the Rideau Canal, built in the year 1832, overcoming the 80 feet difference in levels between the Ottawa River and the Rideau Canal, (2) the Limestone face of Major Hill Park, along which the C.P.R. line approaches, (3) the Interprovincial Bridge crossing the Ottawa River and connecting the Provinces of Ontario and Quebec, (4) the City of Hull with (5) the Laurentian Hills in the background, (6) the Chaudiere Falls and (7) the Timber Slides.

2.30—3.00 P.M.—Thirty minutes will be devoted to an inspection of the Parliament Buildings, including the Parliamentary Library, the Senate Chamber and the House of Commons. The Corner Stone of these buildings was laid in 1860, by the Prince of Wales, who afterwards became King Edward VII., and the buildings were completed about 1866.

3.00—3.30 P.M.—From Parliament Hill a visit will be made to Rockcliffe Park, passing through Rideau Hall grounds, the official residence of His Royal Highness the Duke of Connaught, Governor-General of Canada.

3.30—4.10 P.M.—From Rockcliffe Park to the Dominion Government Experimental Farm via the Driveway.

4.10—4.40 P.M.—Inspection of the Dominion Government Experimental Farm and the Astronomical Observatory.

5 00—5.40 P.M.—From the Experimental Farm the drive will be continued to the Chaudiere Falls on the Ottawa River. Inspection of the Water Power Dam controlling 50,000 horse-power will be made, also the Hydraulic Power Plants, Electric Stations, Saw Mills, Pulp and Paper Mills.

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

6.00 P.M.—The return trip will be through the City of Hull in the Province of Quebec, and over the Interprovincial Bridge. Attention is again directed to the view from the bridge of the Parliament Buildings, Chaudiere Falls and the lower Ottawa River.

In the evening at eight o'clock, the members of the International Congress of Navigation will be tendered a dinner at the Chateau Laurier by the Government of Canada. At the same hour the ladies, accompanying the members of the International Congress of Navigation, will be tendered a dinner at the Chateau Laurier by Mrs. R. L. Borden, and the wives of the Members of the Government of Canada."

Mrs. R. L. Borden very kindly received and presided over the entertainment of the ladies of the party in Ottawa.

A special steamer through the Coteau and Cedar rapids afforded opportunities for seeing the navigation of the rapids, and the party was enabled to inspect the lower portions of the Soulanges Canal.

At Montreal, which was reached on Sunday evening June 16th, the excursionists were met by a Committee of the Council of the Society and conducted to the Place Viger Hotel. The following local programme was observed in Montreal, and opportunities given for inspection of the city and especially of the shipping facilities of the harbour of Montreal were greatly appreciated by the visitors.

MONTREAL PROGRAMME

FOR MEN

9.00—10.30 A.M.—Drive on Mount Royal, to terminate at Wharf for Harbour Commissioners' excursion.

10.30 A.M.-1.00 P.M.—Excursion on Harbour. Landing to be made at Wharf adjacent to Place Viger Hotel. Lunch at Hotel privately.

3.00 P.M.—6.00 P.M.—(a) Visit to Angus Shops by street cars, or (b) Automobile drives to various points.

Provision will be made for persons who desire to visit the Universities or other places in which they are specially interested.

8.00 P.M.—Complimentary dinner by the Harbour Commissioners at Montreal Club, Dominion Express Building, St. James Street.

FOR LADIES

10.00 A.M.—Drive on Mountain.

1.00 P.M.—Luncheon by Ladies' Committee at Windsor Hotel.

3.00 P.M.—6.00 P.M.—Automobile drive. Dinner at Forest and Stream Club.

June 18th 9.00 A.M.—Board Government steamers Lady Grey and Sir Hugh Allan for Quebec."

The banquet by the Chairman and his associates of the Harbour Commission was an important occasion and these gentlemen deserve the heartiest congratulations and thanks for their assistance in entertaining the guests.

On Tuesday morning, the greater portion of the party, accompanied by a number of Montreal gentlemen and ladies, embarked on the Government steamer "Lady Grey" for the trip down the river. The remainder of the party took passage as the special guests of the Montreal Harbour Commissioners on the steamer "Sir Hugh Allan." The trip down the river was in every way a successful one and the party was safely landed at Quebec in the early evening and conducted to the Chateau Frontenac Hotel. On Wednesday an unofficial programme was observed in Quebec with the assistance of members of the Society resident there.

It was in a large measure [illegible] courteous and substantial assistance given by the Corporation and Associations [illegible] in the foregoing and to the efficient co-operation of the other [illegible] of this Society that the visit of this important body of [illegible] to Canada was so successfully carried out. The [illegible] made to the entertainment of our guests material[illegible] necessary expenditure on Government account and made it possible to carry out the enterprise within the amount of the grant.

On behalf of the Society,

C. H. McLEOD

Montreal, August 1st, 1912

The foregoing Report was transmitted to the Honourable Minister of Marine and Fisheries on November 1st last in accordance with instructions of the Council and was acknowledged as follows:

Ottawa, November 5th, 1912

Sir,—

I [illegible] acknowledge the receipt of your letter of the 1st instant, covering your very interesting report on the excursion of members of the twelfth International Congress of Navigation through Canada in June last.

From it as well as from reports received from Col. Anderson, Government Delegate from the Department, I learn of the great assistance rendered to the Government by the Canadian Society of Civil Engineers, and I would now ask you to convey to the Council of the Society my sincere acknowledgment of and the thanks of the Government of Canada for the valuable services rendered gratuitously by your Society by the several local branches and by yourself as Secretary, and which contributed in so great a degree in making the Canadian excursion a very signal success.

Yours sincerely

(Signed) J. D. Hazen.

Prof. C. H. McLeod,
Sec. Can. Soc. Civil Engineers,
Montreal, P.Q.

SUBWAY AND BRIDGE COSTS.

A reinforced concrete highway bridge spanning two railway tracks, waterproofed, paved with vitrified brick and designed for a moving weight of 100 lbs. per square ft. of floor area, or a 10-ton road roller, can be built for $1.65 per sq. ft. of floor, including the spans, supports and ordinary foundations, according to a statement made by H. N. Rodenbaugh, assistant engineer, Southern Railway, Atlanta, Ga., in a paper read before the Engineering Association of the South. Such a structure is only slightly higher in first cost than the typical steel girder bridge of similar capacity with a wooden floor, which costs about $1.50 per sq. ft. of floor area complete. A very satisfactory wooden Howe truss bridge of modern design has been built by one railway at a total cost of $45 per sq. ft. of floor area, and as between the latter two structures, Mr. Rodenbaugh very much favors the wooden bridge. Commenting on shallow floors, which are very common in subway design, he states that a typical open floor—that is, one having ties resting on steel stringers without ballast—will have a depth from base of rail to under clearance of about 3 ft. 4 in., and will cost about $1.20 per sq. ft. of floor area. A transverse steel I-beam construction with ballasted deck on flat plates will have for the same span a depth of 3 ft. 1 in., and will cost about $1.90 per sq. ft. of floor area.

Report of the Annual Meeting of the Canadian Society of Civil Engineers, held in Montreal, Jan. 28, 29, 30, 1913

NEW INTAKE PIPE, OTTAWA, ONT.

By L. McLaren Hunter.*

A new intake pipe was necessary to supply water to Ottawa, owing to the condition of the old pipe which, after the last typhoid epidemic, was investigated, thoroughly examined, and proved to be in a very leaky condition.

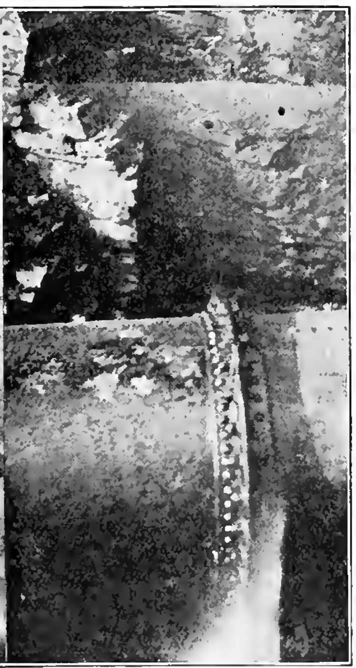
Tenders were called and the contract was awarded to Messrs. Laurin and Leitch, of Montreal, who contracted to finish the aqueduct section of the intake by December 1st, 1912. The council offered a bonus of $200 for every day that the pipe was completed before the specified day for completion, and a fine of $200 for every day over the specified date.

The new intake is a forty-two-inch lock-bar steel pipe, one-quarter inch thick, made by the East Jersey Pipe Company, of Paterson, New Jersey. The length of the intake is twenty-four hundred feet

In connection with the pipe, three twelve-million Imperial gallons per day, electrically driven pumps of the Rees Roturbo type, and run by Canadian General Electric motors, were placed at Lemieux Island—the mouth of the intake. These pumps have a lift of twelve feet, thus throwing the whole line of the 42-inch steel pipe, supplying the city, under a head of water sufficient to insure the pressure being outwards all along the pipe line.

The pipe thus far has proved very satisfactory, and during the hydraulic test withstood the guaranteed pressure without a leak being noticed.

Pipe Entering Tunnel of Aqueduct.



Detail Photograph of Joint Between Old and New Intake.

The construction of the pipe was in the charge of Mr. William Storrie, A.M.Inst.C.E., and was carried out in a very expeditious manner, the contract being let on October 2nd, 1912, and completed by November 21st. The city was being supplied with water through it on the 27th of the same month.

* Of the City Engineer's Department, Ottawa.

TIN PLATE PRODUCTION AND CANADA.

During 1912 the United States have largely extended their exports, and Britain has been meeting their serious competition in neutral markets, such as Canada and Japan, state Messrs. Sims and Coventry, in their report on the tinplate market during 1912. British exports to the former country are considerably smaller than they were some years ago and so long as the American makers choose to supply the Canadians with tinplates regardless of whether it pays them or not they will no doubt secure the business. The Canadians are getting the benefit and the Americans seem satisfied with the "honor and glory." At the time of writing there are no exact figures available as to the American output for the year, but as the American mills have been running much more fully during the year there is sure to be a considerable increase over 1911 and there is little doubt that their make will have exceeded that of Britain. In the last report a doubt was suggested as to the American foreign trade being on an economically sound basis.

Joining of the Old Intake and the New One.

New 42-inch Steel Pipe in Aqueduct.

Germany lays claim to having been the original home of the tinplate industry, having, so it is said, begun the manufacture in the fourteenth century. They are now turning out some 50/60,000 tons a year, the figures for three years at intervals of ten being:—

	Tons. 1890.	Tons. 1900.	Tons. 1910.
German manufacture	21,300	30,705	57,136
Imports into Germany	4,296	18,158	46,973

It will be noticed that the imports are increasing more quickly than the home production and a proposal for a considerable extension of the German manufacture has received powerful advocacy. At one time (in the nineties) the German makers supplied 96 per cent. of their home consumption, whereas in 1910 it was only 55 per cent. In 1907 it fell as low as 51 per cent. Now, the advocates of German extension look forward to making a bid for the export trade, and a number of new mills are already at work in Westphalia. The American manufacture has increased by rapid steps. In 1910 their output was 722,770 tons. British exports in that year of tinplates, terneplate and blackplate for tinning were 538,870 tons, and if Britains export trade takes about two-thirds of British make, this would give 808,305 tons as Britains total ouptut for 1910. In 1911, the American make was 783,360 tons and on the same method of computation Britains was 816,630.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., MANAGING EDITOR
A. E. JENNINGS, ADVERTISING MANAGER
P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, FEBRUARY 6, 1913. No. 6.

CONTENTS OF THIS ISSUE.

A NATIONAL ENGINEERING SERVICE.

In these columns, in the issue of January 23rd, we published an editorial on "A National Engineering Service." In another part of the same issue were published two articles which had secured the prizes offered in the competition held under the auspices of the Royal Military College Club and the Canadian Society of Civil Engineers.

We inadvertently stated in that editorial that Mr. T. Chase Casgrain, chairman of the International Joint Commission, had offered the prizes for these essays on the formation of a National Engineering Service. Our attention has been drawn to the error by Mr. Casgrain.

Mr. Charles A. Magrath, and not Mr. Casgrain, was responsible for the offering of the prizes in this competition, and we are extremely sorry that the error should have occurred in our previous editorial. The fact that they are both members of the International Joint Commission was the reason for the mistake. The fact that Mr. Magrath has interested himself in the discussion of the formation of a National Engineering Service is sufficient to convince those who know him that some result will be achieved. As a member of the engineering profession in the past, his work has always been marked by accuracy and efficiency, and it is, no doubt, due to his intimate knowledge of the profession that he has appreciated more fully the necessity for a change in the method of administration of engineering service for the federal government. This move on the part of Mr. Magrath is but the forerunner of some plan of concentration and co-operation in the government service.

The matter was discussed at the annual meeting of the Canadian Society of Civil Engineers, held in Montreal last week, and, while no decision was arrived at, it is plain to see that the feeling of the members is strongly in favor of some such system as is outlined in the two essays by Evolu and Observer, printed in the issue of January 23rd.

We would again express our regret that Mr. Magrath was not given the credit for initiating this movement and that the error of ascribing it to another man occurred.

LIABILITY OF CANADIAN RAILWAYS

During the year ended June 30th, 1912, $21,251,664 was added to the stock liability of Canadian railways and $38,996,661 on account of funded debt, representing a total addition of $60,248,325. That increase over the figures of 1911 brought the total capital liability of Canadian railroads up to $1,588,937,526. These figures in themselves are of interest, but more so because considerable railroad construction has yet to be undertaken in the Dominion. The railroad stocks last year totalled $770,459,351 and the funded debt $818,478,175, so that stocks and bonds are about equally divided. It is interesting also to examine the division of the funded debt. This is set forth in the excellent volume of railway statistics compiled by Mr. J. L. Payne, Comptroller of Statistics of the Department of Railways and Canals, at Ottawa. The figures are as follow:—

Funded debt.	1912.
Bonds	$772,532,108
Miscellaneous obligations	12,608,718
Income bonds	17,119,466
Equipment trust obligations	16,217,883
	$818,478,175

The constant call of the Canadian roads for new equipment is reflected in the equipment trust obligations for the past few years. The amount for 1910, 1911 and 1912 exceeded $42,000,000. The Grand Trunk Railway for the first time adopted this form of financing last year.

Mr. Payne calculates the capitalization per mile of our railways. If the total capital liability of $1,588,937,526, as given above, be divided, he says, by the 26,727 miles of operating line shown on a preceding page, the result would be $59,454 per mile of line. It would be quite misleading, however, to make such a calculation. Neither the divisor nor the dividend is correct. The mileage, for example, includes Government owned and operated lines, to which no capital liability attaches. On the other hand, the capital figures embrace the liability of unfinished lines, such as the Grand Trunk Pacific, which do not appear in the mileage column. The deductions under this head amount to $134,321,020. Then there is considerable duplication. It has not been practicable to ascertain the exact amount thereof, created chiefly by the issue of stocks and bonds for the purchase or control of smaller roads by the larger, but it is known to be not less than $210,000,000. Joining these two sums, and subtracting the total from the $1,588,937,526 already indicated, the remainder is $1,244,616,506. For immediate statistical purposes that might be regarded as the proper capital liability of Canadian railways.

The elimination of Government owned lines, and such other lines as should not figure in the mileage column, reduces the total to 24,485. Using these factors, it will be seen that the capital liability of railways in Canada amounts to $50,832 per mile. This is a relatively low figure.

The net capitalization per mile of line in other countries is as follows:—

Country.	Net capital per mile.
United States	$ 59,345
United Kingdom	275,166
France	94,933
Germany	111,737

The cost per mile of the government owned railways in Canada has varied considerably. The Intercolonial with 1,463 miles of line has a cost per mile of $64,761; the Temiskaming and Northern Ontario Railway, $58,495; the Prince Edward Island, $32,296; and the New Brunswick Coal and Railway, $33,398.

The capital liability of Canadian railways has grown enormously in the past few decades. In 1876 railway stocks totalled $181,000,000 and the funded debt $76,000,000, an aggregate of $257,000,000. In 1900 the stock indebtedness had expanded to $410,000,000 and funded debt to $373,000,000, a total of $784,000,000. In 1908 the funded debt for the first time exceeded the stocks, the figures being respectively $631,000,000 and $607,000,000, or a total sum of $1,238,000,000. Last year, as mentioned above, the stocks had reached $770,000,000 and funded debt $818,000,000. The growth in stocks since 1876 has been $589,000,000, or 325.4 per cent.; in funded debt $742,000,000, or 976.3 per cent.; in total capital liability $1,331,000,000, or 517.9 per cent.

The relationship of dividends and net earnings to share capital have shown some interesting fluctuations during recent years. In 1907, the percentage of dividends paid to share capital was 2.17, and this percentage changed year by year as follows: 1908, 2.11 per cent.; 1909, 2.97; 1910, 3.16; 1911, 4.08; 1912, 4.04. The percentage of net earnings to share capital in 1907 was 7.30. In 1908 it declined to 6.51, and in the following year to 6.24. In 1910 it increased to 7.78 per cent.; next year it declined to 7.70 and last year rose to 8.91. Of the total dividends paid in 1912 amounting to $31,164,791; on common stock, $18,487,000 was paid; and $12,677,791 on preferred stock.

LETTER TO THE EDITOR.

Sir.—We notice on page 901 of your issue for December 19th, 1912, that the Stereophagus Pump and Engineering Company, Limited, control the Canadian rights of the Hon. R. C. Parson's pump. Permit us to point out that this is liable to give a wrong impression, as we made the earliest pumps and hold the license for this pump in every part of the world. We are, therefore, in a position to supply to Canada.

Yours faithfully,

THE PULSOMETER ENGINEERING CO., Limited.

Reading, England, January 21st, 1913.

MONTREAL'S BOARD OF TRADE

The annual meeting of the Montreal Board of Trade brought out some remarks by the retiring president, Mr. Robt. W. Reford, on a point of much economic interest and importance. He referred to the selling to industries on the other side of the international boundary line of power generated in Canada. He questioned whether it was wise to permit the export of power developed near Montreal as the growth of the city depended to such an extent upon cheap power. He also regretted the failure of the provincial government to appoint a hydro-electric commission for the purpose of fixing electric power rates. He asked the members of the board to consider whether the manufacturers were not paying too much for power by generating it by steam when a great heritage in water power lay at the very doors. He said that notwithstanding all the water power at the doors of the city the companies which had acquired he powers had been selling the power out at a price apparently governed by the cost of power when generated by coal.

Mr. Reford also referred to the high cost of living, saying that one of the factors was the permission enjoyed by the public utility companies to issue as much capital as they saw fit or as they had prospective power to pay dividends upon at the rate of five or six per cent. All this was increasing the cost of living. Cheap electrical power, cheap transportation and other public utility services would place the manufacturers in a better position to compete and to pay higher wages. After all the capitalizing and re-capitalizing had taken place, the stock eventually found its way into the hands of shareholders who would be the sufferers when the power to charge high rates was curbed. Meantime, the promoters were left to enjoy their illegitimate profits without any interference whatever.

The British Columbia Electric Railway Company plans the construction of additional repair and car-making shops in Burnaby municipality, in addition to the shops they already have at New Westminster. The shops will employ about 500 men.

The new line to Eburne over Oak Street is now in operation. This line runs directly south from Broadway to the Fraser River, Oak Street being five blocks east of Granville. The ultimate plan is to have a double track down Granville to Eburne, when a belt line will be run around Oak, Broadway, Granville and Eburne.

THE MOUNT ROYAL TUNNEL OF THE CANADIAN NORTHERN RAILWAY.

Headings aggregating over a mile in length have already been driven for the Mount Royal Tunnel of the Canadian Northern Railway. A summary of the general scheme and the construction methods was given on page 812 of The Canadian Engineer for January 16, 1913, and the reader is requested to turn to that article, as the points brought out therein need not be repeated.

In view of the rapid progress made since Chief Engineer Brown prepared his excellent paper for the Canadian Railway Club, some photographs and additional notes regarding the work may be of interest.

Four headings are being driven simultaneously—one eastward from the West Portal, one westward from the Dorchester shaft, and one each way from the Maplewood shaft. All four are bottom centre headings. The headings have advanced approximately two thousand feet from the West Portal, sixteen hundred feet from the Dorchester shaft, and a thousand feet each way from the Maplewood shaft. A temporary heading has also been driven eastward from Dorchester shaft nearly to Lagauchetiere Street.

The approach to the West Portal is through a cut about a half mile in length and twenty feet deep at the portal. This cut is through the Model City and will be bridged at the street crossings. Just west of the portal it passes under the Canadian Pacific Railway tracks. Fig. 2, looking west through the site of the Model City, shows the steam shovel making the cut. Fig. 3 shows the West Portal. The compressor house, repair shop, etc., are in the background.

Fig. 4 is a photograph taken from a high cliff on the mountain showing the location of the Maplewood shaft, which is about a mile east of the West Portal and about two and a fifth miles west of the Dorchester shaft. This shaft is almost exactly at the centre of the photograph. The Maplewood shaft is 250 feet deep, the Dorchester shaft 55 feet deep.

Fig. 2.—Steam Shovel Making the Cut at the West Portal

Illustration No. 5 was obtained while the Dorchester shaft was being sunk. The Dorchester shaft is so named because it is immediately alongside of Dorchester Street, almost opposite the old headquarters of the Canadian Society of Civil Engineers. The Maplewood shaft is near Maplewood Avenue, Outremont.

The headings are 9 feet high by 12 feet wide at present. The full size section will be 20 feet high by 28½ feet wide. The work of enlarging to the full size is just being started. Average progress from the Dorchester shaft has been 12 feet a day, although there have been 20 foot days. No shooting is allowed between 11 p.m. and 6 a.m. At the west end, where shooting is allowed at night and stronger blasts possible without public annoyance, the average has been 20 feet per day.

Chief Engineer Brown says that the photograph from which illustration No. 1 was made is one of the best tunnel photographs that he has ever seen. It shows clearly the face of the heading with the four drills mounted on the horizontal bar. Immediately back of the point from which this photograph was obtained, is a large pile of muck from which the laborers shovel off slick sheets into low cars.

Fig. 1.—Face of Leading, Showing Rock Drills Mounted on Horizontal Bar.

Illustration No. 6 shows the cap and post system of timbering which is being used. In his paper before the Railway Club, Engineer Brown said: "The cap and post system is very similar to the segment system, except that the segments are not self-supporting. This system is used in very heavy ground and posts and rakers are used similar to those in the crown bar system. The crown bar system consists of bars (usually of wood) set up parallel to the axis of the tunnel and poling boards driven outside them, almost tangentially to the surface of the tunnel excavation. The crown bars are supported by posts and rakers, so arranged as to best suit the nature of the ground and the methods of excavation and lining.

"The segment timbering system—used in lighter ground—consists of a series of timbers cut in segments, approximately to fit the form of the tunnel cross-section, when set up in a plane vertical to the tunnel axis. The poling boards are driven outside the segments nearly parallel to the axis of the tunnel. The segment timbers are ordinarily self-supporting. This system is often used where only the roof is soft and the segments can be sprung directly from plates on the rock walls"

The Montreal tunnel will not likely require much timbering during construction and as the rock will likely be safe, much of the tunnel may be left permanently unlined. The character of the rock is principally limestone and volcanic in-

trusion. Up to the present time, the headings have gone through Essexite, Trenton limestone and dykes of trap rock, and the engineers expect to strike considerable Nepheline syenite. The engineers do not expect to find any faults in the rock. If they do, they will deal with the emergency as it arises. If they strike water in the headings going up, they will drain it out; if in the headings going down they will pump it out, for which purpose several pumps of the centrifugal type have been provided. They do not expect to strike much water, however.

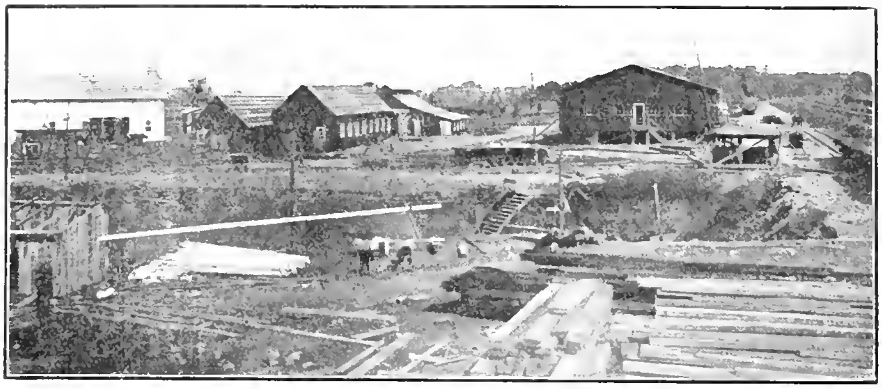


Fig. 3.—Western Approach to the Tunnel.

The tunnel will be lined with concrete. The cement gun method of depositing concrete through pipes with compressed air, like grout, is being investigated, and may be used.

The final designs for the tunnel are not yet decided upon, but it is likely that it will be a twin tube throughout, with a concrete centre wall to facilitate ventilation. In single tube tunnels, where the cross-section is small compared with the bulk of the trains, the piston action of the trains themselves gives excellent ventilation if the portals or openings are free.

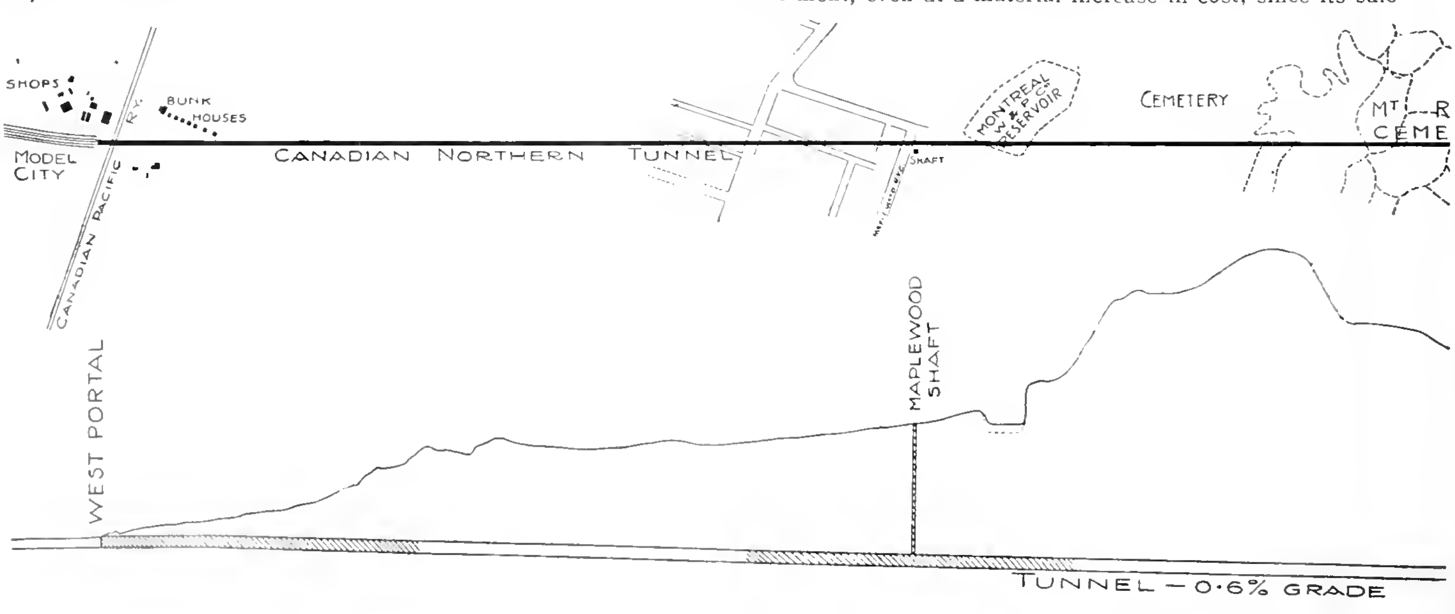
The permanent track in the tunnel will probably be constructed on a concrete base, with creosoted wooden blocks set in the concrete, on which tie plates and screw spikes are used. With this type of construction, a gutter in the centre affords splendid drainage, and the grade and alignment are fixed perfectly. The wooden blocks can be easily removed and renewed. While the engineers favor this type of construction at present, a track laid in rock ballast is also being given consideration and may be used for portions of the tunnel, if not for all of it.

All the very latest signaling devices applicable to this type of tunnel and proven efficient by trial in tunnels in New York City and elsewhere, will be installed in the Mount Royal tunnel. The track will be divided into sections or blocks, the length of which will depend on the grade, curvature, speed and weight of trains, etc.

At the end of the block section an insulated joint is inserted between the ends of the rails, with this type of signal installation. A source of electric current is connected at one end and a track relay at the opposite end, at which end the signal is also installed. The connections are so made that the electric current passes through the rails and relay when there is no train in the block, the relay holding the signal at clear position. When a train enters the block the current takes the path of least resistance through the wheels and axles and is thus cut off from the relay which then allows the signal to fall to "danger" by gravity. If the electric current should fail for any reason, or if the rail should be broken, the signal would go to "danger," just as though a train were occupying the block.

When a block signal is set at "danger" it must be passed, so if only one signal were placed at each block station it would be necessary to approach each signal at a speed which would permit stopping the train at each signal, in case it were found at "danger." To avoid this difficulty, a second signal, called the "distant signal," is installed, which follows the movements of the other, called the "home signal." The distant signal is located so that the train can be easily stopped at the home signal, in case it is in the danger position, as indicated by the distant signal. This signal is usually placed on the same mast with the home signal of the next block, and immediately below it. Within the tunnel lights are substituted for the semaphore arms, the red light being "danger," the yellow for stop position of the distant signal or "caution," and green for the clear, of "proceed" position of both home and distant signals. A safety latch is so placed that if the train runs by a signal set at "danger," the brakes are automatically set and the train stopped.

Engineer Brown is a firm believer in buying good quality of machinery for his plant, as he says it is usually the best investment, even at a material increase in cost, since its sale-



Plan and Profile on the Line of the Mount

able value at the end of the job will be so much greater. Also standard, advertised machinery is easier to dispose of than special equipment. As the plant is only temporary, however, expensive fuel and labor-saving devices cannot usually be installed, as they would not have time to pay for themselves, unless the saving is very large. Duplicate machinery is installed in critical places, so that if a unit gets out of order, the job will nnt be shut down.

Illustration No. 7 shows the compressor house at the

Fig. 4.—Showing Location of the Maplewood Shaft. The Shaft is Almost Exactly at the Centre of the Photograph.

Dorchester shaft. It is duplicated exactly at the West Portal. There are three belt-driven, cross compound compressors, 1,100 cubic-feet per-minute capacity, with induction motors, 225 h.p., 170 r.p.m. These can be seen in the background of the illustration, while in the foreground can be seen parts of a direct-connected, cross compound unit which has since been erected, having a capacity of 2,160 cubic feet per minute, compressing to 100 pounds. This compressor is driven by a synchronous motor, 400 h.p., 170 r.p.m. The power is three-phase, 62½ cycles at 2,200 volts.

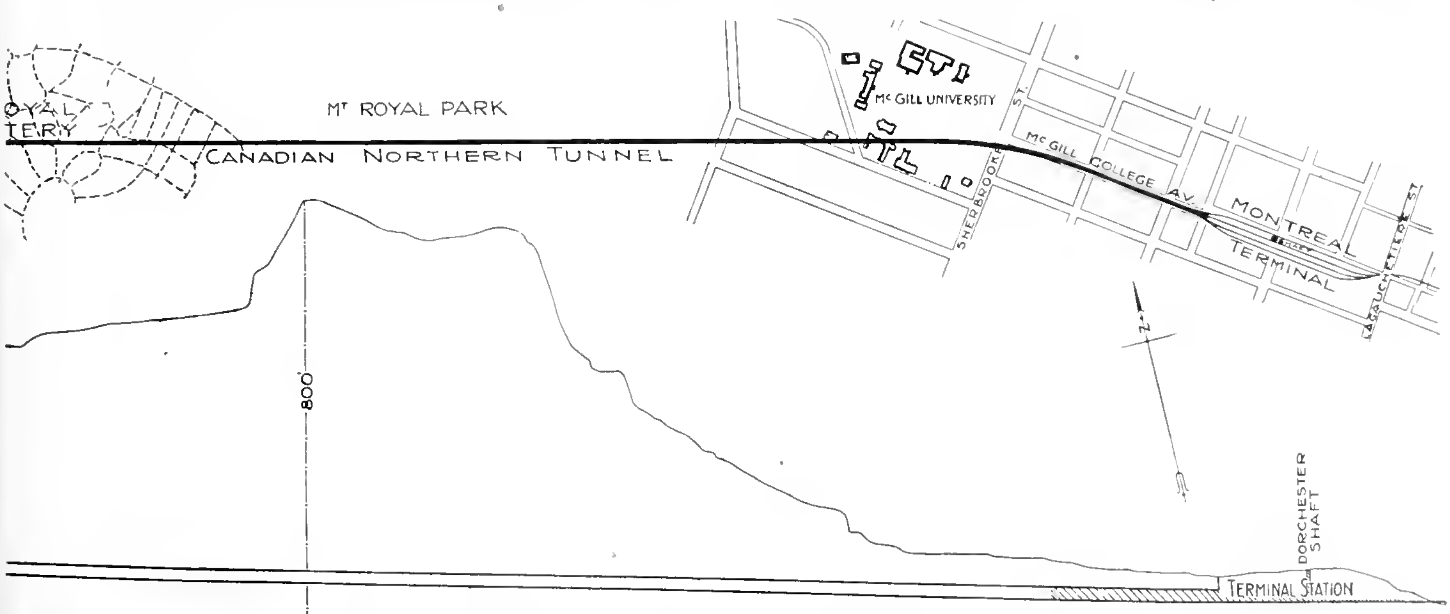
24-inch gauge, V-shaped muck trucks were used at first, but the muck cars now being used are 3-foot gauge, very low and narrow, so that a mucker can shovel into them at maximum efficiency. The wheel base is short. Axle springs reduce the number of derailments resulting from poor track. Gasoline locomotives are used at the West Portal, horses at the Maplewood shaft, and storage battery electric locomotives at the Dorchester shaft. Facilities for recharging the batteries have been provided at the shaft. It is said to be the intention to use storage battery locomotives in the near future at the West Portal and the Maplewood shaft also.

The tunnel is ventilated by forcing fresh air through pipes into the working areas under pressure from blowers driven by motors near the portals. The exhaust from the drills also aids ventilation materially.

Fig. 5.—The Dorchester Shaft.

There is a hospital plant at the West Portal, though its services have been needed but little as yet. Up to the present time the city hospitals have been relied upon in connection with the Dorchester and Maplewood shafts. A well-equipped repair plant has been erected, as even in the city of Montreal, where shops are readily accessible, it was deemed wise to have a complete repair shop on the job, as delays were apt to occur in outside shops over which the tunnel engineers would have no control. As all money spent in tunneling is dead capital until the tunnel is completed, every moment counts, and it was estimated that a few days' delay would cost more than the shop.

Illustration No. 8 shows the engineering corps making precise measurements. Tunnel Engineer Fisher succeeded in throwing a base line directly over the obstacles under which the tunnel passes and in the vertical plane of the tunnel tangent axis. The tapes were calibrated to a standard measure and temperature at a given tension. Readings and measurements were taken independently by each instrument



Royal Tunnel of the Canadian Northern Railway.

man and rod man of the baseline party, and the result summarized by the chief of party to eliminate the personal element.

In this work the tape was anchored at one end to a heavy weight, so that when stretched ahead it passed over a spider with a brass cross hair plate on it. This spider marked the last station measured to. The other end of the tape was attached to a standard weight by a chord passing over a vertical bicycle wheel, thus keeping the tape at the standard tension, and the next measuring spider was set close to this end. The tape was supported at regular intervals and thermometers enabled it to be corrected for temperature. Level readings on the spiders gave the correction for inclination and, as the spiders were set up on transit lines, the final result was a very accurate transverse.

Fig. 6.—Showing Cap and Post Method of Timbering

The baseline was extended down the shafts by plumb lines consisting of heavy weights suspended on piano wire. From these plumb lines the engineer's line was projected into the tunnel. Permanent points and centre line stations were marked by wooden plugs with steel spads.

A visitor to the Mount Royal tunnel is chiefly impressed with the orderliness and absolute lack of confusion with which the work is progressing. Great credit must be given to the four engineers who are chiefly responsible for the work for the swift and precise manner in which the whole undertaking has been handled to date. Although a large gang of men is necessarily being handled (the drills alone requiring about one hundred men, there being three shifts a day, four headings, four drills to the heading, a runner and a helper to each drill), the entire work is excellently regulated. Stephen P. Brown is chief engineer; J. C. K. Stuart, assistant engineer; Howell T. Fisher, tunnel engineer; W. C. Lancaster, mechanical and electrical engineer.

On the line drawing published herewith showing the plan and section of the mountain and tunnel, the shaded portions of the tunnel indicate the progress made in driving the headings. The heading being driven west from the Maplewood shaft will probably meet that being driven east from the West Portal late in the fall of this year. It is estimated that it will take about two years to complete the tunnel. It will be noted that the tunnel curves under McGill University grounds and follows the centre line of McGill College Avenue, as where the covering is light the engineers did not wish to go under a portion of the city where somebody might desire to put up a skyscraper with deep foundations.

The scale to which this drawing was made was one inch to 200 feet horizontally and one inch to 50 feet vertically. The engraving for the illustration was then made about one-seventh the size of the drawing. The straight portion of the tunnel is 76 degrees 33 feet 55 inches N.W.

A few notes concerning the mechanical arrangement of the drills now being used on the work may also be of interest. Essentially the drill is an ordinary rock drill of the reciprocating type with a piston and rifle bar bored out to permit the insertion of a small tube, adjustably secured in the back head of the machine. Water under pressure is conducted by a hose line and fittings to the mouth of this tube, through which a constant jet passes into the pollow piston rod and thence into the hollow drill steel, held in the chuck of the machine. The hole through the drill piston is enlarged for a certain distance from the point at which it ends in the counterbore for the rifle bar, and the function of this opening or secondary counterbore is to connect an impulse of exhaust air from the rear of the piston chamber down through the hole in the piston, when it withdraws from the lower end of the tube, which happens at the instant of reverse on its forward stroke. This action causes a charge of mingled air and water to pass through the hollow drill steel to the cutting face of the bit, which, with the water which passes through when the piston is lifting, has the effect of ejecting the cuttings in the form of sludge from the drill hole. It also insures a clean rock surface for the bit to strike and prevents the hole from mudding up regardless of its direction.

When working under normal conditions, air from the cylinder is not admitted to the hollow piston until after the valve is reversed, with the piston on its forward stroke. The air consumption of the machine is therefore the same as if there were no water tube, because the air which would ordinarily be exhausted by the valve passes through the drill steel, and no live air can be admitted for this purpose.

Fig. 7.—Compressor House.

If, however, the conditions of the ground warrant it, a charge of live air from behind the piston may be directed

into the drill steel, and this will be followed by the impulse of exhaust air as the piston nears the forward end of its stroke. This may be accomplished by pulling the tube farther back into the head and then securing it by screwing down the lock plug upon the rubber sleeve. By thus manipulating the water tube a varying proportion of air and water may be admitted to the drill hole to handle to the best advantage the particular kind of rock that is being drilled.

The water tube is secured in the back head by the rubber sleeve and gland or lock plug just mentioned. Water is introduced through a water elbow and hose fittings, which include a spud, containing a screen to prevent foreign matter from entering the tube, and a screw cap to keep out dirt when

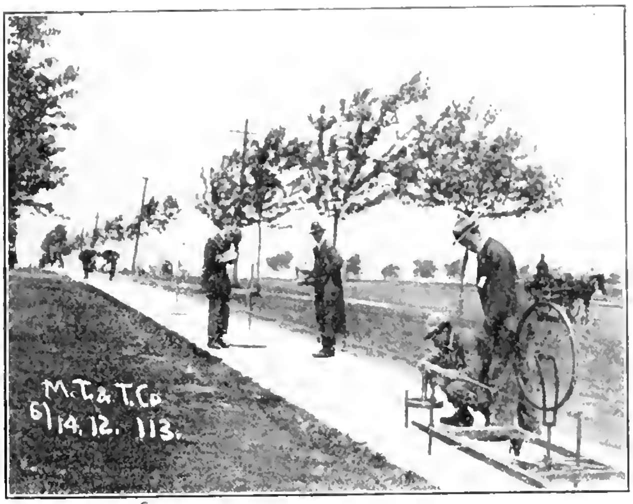


Fig. 8.—Precise Measuring Engineer Corps.

the hose is disconnected. A removable plug is provided to limit the amount of water admitted.

Water under a pressure of from 50 to 100 lb. per square inch is required for clearing the hole of its cuttings. Round, hollow steel is used and requires no shanking. The bit is the regular cross shape similar to that commonly used with solid steel.

The general operation of the drill is the same as that of the ordinary reciprocating or so-called piston machines. The water drills are mounted on horizontal 11-foot heading bars, with a leg or support in the centre to secure stiffness. Four drills are used at once on each bar. When the rock is unusually hard, three double screw mining columns are used instead of the bar. Two drills are mounted on arms on each of the two outside columns, and a fifth drill on the centre column. In one heading the drills have cut as high as 20½ feet per hour per drill. This does not include setting up, but does include changing steel, lining up holes, etc. The average depth of holes is 5½ feet and the average speed per drill hour 16½ feet. In sinking a shaft with 7-foot cut holes and 5-foot line holes, an average of 8.6 feet per hour per drill was maintained (total drilling time). In another heading, where the rock is harder, the four drills cut 13 feet per drill hour, or eighteen 5½-foot holes in two hours.

Application will be made to the Ontario Legislature at its next session for an act amalgamating the North Lanark Railway Company with the Ottawa and St. Lawrence Electric Railway Company under the name of the Ottawa and St. Lawrence Electric Railway Company, and increasing the capital stock from $1,000,000 to $5,000,000 by the creation of 40,000 additional shares of $100 each; and for power to issue bonds and borrow money to the extent of $30,000 per mile of the railway.

INTERNATIONAL ROAD CONGRESS, JUNE, 1913.

Although over six months have still to elapse before the opening of the Road Exhibition in the Royal Horticultural Hall, the preliminary arrangements have all been completed and over half the available stands have been already applied for.

The exhibition will be attended by representatives of highway authorities from all parts of the world. It will be unique in its character, and will bring together for the first time a representative exhibition of road-making materials and appliances, including heavy road machinery.

The organization of the exhibition is in the hands of a committee of which the Right Hon. Earl Beauchamp, K.C.M.G., is president. Other members of the committee are Sir Maurice Fitzmaurice, C.M.G., Colonel R. E. Crompton, C.B., Messrs. Alfred Dryland, Howard Humphreys, T. Richards, Wallace E. Riche, Gibson Thompson, J. Walker Smith, John Willmot and Rees Jeffreys. The honorary secretary is Mr. H. P. Maybury, and the assistant secretary and manager Captain L. A. Kingston.

The exhibition committee is assisted by an advisory committee of traders and exhibitors. The members of this committee are Messrs. H. Pitts (chairman), H. Beadle, H. D. Blake, F. E. Bristowe, E. B. Chittenden, D. G. Comyn, W. Penrose Green, F. W. Manuelle, and H. L. Wettern.

The following table shows the position of the letting of stands at the present time. It is to be regretted that the limitations of space will preclude all the firms who desire to do so from exhibiting.

No. of Stands.	In Hall.	In Machinery Section.
Let	26	7
Under negotiation	14	6
Reserved for foreign exhibitors	10	4
Unlet	16	8
	—	—
Total	66	25
Grand total	—	—91

Among the exhibitors in the Horticultural Hall (for small exhibitors) will be found Messrs. J. and P. Hill-Galloways, Limited; The Anglo-Mexican Petroleum Products Company, Limited; The Limmer Asphalte Company, Limited; Taroads, Limited; The Neuchatel Asphalte Paving Company, Limited; Roadamant, Limited; Tarmac, Limited; The Gas Light and Coke Company, Limited; Rocmac, Limited; Roadite, Limited; The Canadian Mineral Rubber Company, Limited; The Enderby and Stoney Stanton Granite Company, Limited; F. E. Bristowe and Company; Krupka and Jacoby; Ellis and Everard; Iliffe and Sons; J. Hutchinson; Crompton and Company; Good Roads; Roads Improvement Association, and The Surveyor, etc.

The exhibition will be open daily from 9 a.m. to 8 p.m. to members of the congress and their friends, and in view of the fact that the meetings of the congress will take place in close proximity to the hall the exhibition will form a rendezvous for informal discussions. Afternoon tea will be provided at the exhibition for members of the congress immediately after the formal meetings have been concluded.

The executive committee will be glad to welcome any offers of assistance, and at present the matter of laying out the footpath of the exterior section is under consideration. The paths, which are of the width of 12 feet throughout and cover some 750 square yards, could be apportioned in sections to road surfacing and other firms who desire to make a display of their various specialities in paving. Applications for further particulars can be obtained from Mr. W. Rees Jeffreys, honorary secretary, local organizing committee of the

International Road Congress (London, 1913), 72 Queen Anne's Chambers, Westminster, S.W.

MAINTENANCE ENGINEERING IN RAILROAD WORK.*

The chief enemy of the maintenance engineer is water in some form or other. Drainage should not be forgotten in the early stages of an engineering work. Do not dip a road to get under a railway, or a railway to get under a road, without some thought as to the possibility of draining the depression proposed.

In dealing with steel bridge floors there are three courses open to the designer: (1) To make the floor as open as possible, with no place for water to lodge, and every facility for its getting away quickly; (2) to protect the steelwork floor so thoroughly that water cannot get to it; (3) a compromise course. Even the worst drained bridge, however, does not suffer so much as one over a railway, with a floor so designed that steam and gases from locomotives cannot escape freely.

When a structure fails, it is important that a correct diagnosis should be made. Otherwise the treatment may be all wrong, and may lead to large expenditure, when something quite simple and inexpensive would have met the evil equally well.

One instance is recalled where an intelligent inspector, climbing among the girders of a viaduct 140 feet high, found that there were signs of movement where the girders rested on the piers. The first thing to find out was whether the girders were moving on the pier, or the pier moving under the girders; and observations extending over some time were necessary to settle this point. There was then no doubt that it was the pier that was moving and getting increasingly out of plumb. Fortunately, the next pier was an unusually massive one, and it was possible with a system of tie rods attached near the base of it to get hold of the faulty pier near the top, and entirely stop the movement. From the date of the first observations to the tightening up of the tie rods, there had been a movement of 1¼ inches.

Similarly, if one is called upon to deal with an abutment which is bulging and out of plumb, the first thing to find out is, to what the failure is due; is it, for instance, the result of (1) bad foundations? (2) of colliery workings (and old workings which nobody knows much about are sometimes very troublesome)? (3) of excessive pressure from swelling clay or defective drainage behind? or (4) of imperfect building and want of proper bond, or sufficient section in the wall itself? The treatment will entirely depend on the diagnosis. For instance, it would simply be waste of money to rebuild or reface if colliery workings were the cause of the trouble, unless indeed the settlement due to them had quite ceased.

In the design of new works the consideration of the likelihood of future alteration has a bearing on the materials to be used. If it is likely to come soon, one does not build with the some solidity adopted if the structure is to be one of real permanence. In designing bridge work, some of our predecessors in days gone by have added large margins to the calculated strengths of their structures, remembering the effect of corrosion and the tendency to increase the weights of locomotives, etc. We are now reaping the benefit of this liberal policy; for had things been calculated more closely, our maintenance expenditure would now be largely increased.

*Abstract of article in the "Journal" of the Junior Institution of Engineers, London, England, by A. Clifford Swales, Secretary.

HOW NEARLY DOES THE MODERN YELLOW PINE BLOCK PAVEMENT APPROACH TO THE IDEAL PAVEMENT AND WHAT IMPROVEMENTS CAN WE SUGGEST?

By H. L. Collier.

To intelligently discuss the matter let us get forth the cardinal points of an ideal pavement.

1st. It should be sanitary.

2nd. It should be durable.

3rd. It should be reasonable as to first cost.

4th. It should be easily, economically and effectually repaired.

5th. It should offer the least resistance to traffic.

6th. It should furnish good foothold to horses.

7th. It should be easily cleaned.

8th. It should be noiseless.

9th. It should possess elasticity, which would care for the horse.

10th. It should be dustless.

11th. It should have a smooth surface and wear uniformly.

12th. It should not be easily affected by climatic changes.

Finally. This being the automobile age, the ideal pavement should care for the automobile as well as for the horse.

As to the cardinal points, what claim can we make for the modern creosoted yellow pine block pavement?

First. We unhesitatingly say it is the most sanitary of all pavements, because it is made of only sound timber, thoroughly seasoned under a temperature of at least 240 degrees Fahr. in an air-tight cylinder; subject to a vacuum of from 22 to 26 inches of mercury, and under pressure of from 100 to 200 pounds per square inch; creosote oil, a distillate of pure coal tar, free from all adulterants whatsoever, is forced into the blocks until the pores are filled with the oil at a temperature of 240 degrees Fahr.

The heavy oil of creosote, a pure coal-tar distillate, free from adulterations, is not only a wood preserver, but also a most effectual disinfectant; a sure exterminator and preventative of germs, microbes, fungi and all other seeds of disease or decay.

The pores of the yellow pine blocks being thus filled under pressure will not absorb impurities, and creosote being ever present no germ can exist on the surface of the pavement.

Again, the blocks are manufactured to exact dimensions, rectangular in form, and are laid so closely and fitted around manholes, water keys, catch-basins, frogs, switches, etc., so snugly that the interstices are too small to admit any impurities.

Again, there is nothing about a wood block pavement to grind into dust, and no dust can appear thereon except that carried to the pavement; and as dust is not only a disease producer and also a disease distributor, and as all other pavements are at least ninety (90) per cent. dust producing materials, we say creosoted yellow pine block pavement is the most sanitary of all pavements.

Dr. Floyd W. McRea, of Atlanta, one of the most noted surgeons in the south, who served his city on the Board of Health, after a most careful examination of creosoted yellow pine block pavement, not only in this country but also in Europe, pronounced it the most sanitary and the best of pavements.

*Abstract of paper read before American Wood Preservers' Association.

Mr. H. Wheeler Bond, health commissioner of St. Louis, under date of March 2nd, 1911, wrote:

"In our opinion the creosoted yellow pine block pavement is not only sanitary in nature, but also considered the best street pavement in St. Louis."

Mr. James C. Travilla, street commissioner of St. Louis, under date of March 6th, 1911, wrote:

"The modern creosoted block is the most sanitary form of paving material on the market. The reason for this is evident, since the creosote used in treating the wood contains a large percentage of highly antiseptic ingredients, namely, Phenol, or carbolic acid, and Naphthalene. These ingredients are the lighter, more volatile portions of the preservative oil and continually come to the exposed surface of the blocks, the only portion of which collects germs, and thus keeps the street in a healthy, sanitary condition."

Second. We say also that creosoted yellow pine block pavement is the most durable of all pavements, even under heavy traffic. Tested side by side with granite on Hudson Street, New York, it was proven to be more durable. In U. S. Circular No. 141 we find in the above test, "one wood-block pavement outlasted three granite-block pavements under identically the same climatic and traffic conditions."

Williamsburg Bridge, New York, gives proof that wood block pavement is more durable than Medina sandstone.

On Michigan Boulevard, Chicago, asphalt blocks wore out in five years and wood blocks in same location under the same traffic were good at the end of nine years, certified to by Mr. Lynn White, engineer for South Park Commissioners, Chicago. On Holliday Street, Baltimore, after a test of six years, sheet asphalt, asphalt blocks and several different makes of vitrified brick pavements wore out and had to be removed, while wood blocks were perfectly sound and showed only a compression of ⅛ of an inch in the six years. At the present time, after twelve years' service, the wood blocks look as when new and no cost of repairs. All of these tests are described also in U. S. Circular No. 141.

On Tremont Street, Boston, in 1900, the test was made with asphalt by paving from centre to curb on one side with the very best quality of asphalt paving, and on the other side from centre to curb with the best quality of creosoted yellow pine blocks—all on six inches Portland cement concrete foundation. After nine years' service the asphalt was practically worn out, after having been many times repaired, while the wood blocks, according to the superintendent of streets, "seem in as good condition as when first laid; by actual measurement I find that they have been reduced ⅛ of an inch, but the surface is so regular the reduction in thickness of ⅛ inch must be from compression rather than wear. The wood blocks on Tremont Street have not received or required any repairs caused by either wear or decay in the nine years."

Messrs. Dow and Smith, experts of New York, in making their report to the Merchants' Association of Philadelphia looking to the paving of Market Street in said city, made this comment on Tremont Street pavement in Boston:

"To all appearances these blocks, although subjected to severe traffic for the past nine years, are practically as good as the day they were put down. There has been no maintenance cost whatever during the nine years the pavement has been in place."

In the same report Dow and Smith stated:

"Where laid along side of street car tracks the present wood blocks have outworn two sets of granite blocks similarly placed."

"Wood block paving down under heavy traffic from 10 to 12 years shows less than ¼ inch wear or compression, and none as yet having cost anything worth considering for repairs, while the life of all other pavements under heavy traffic is from 8 to 12 years—all requiring extensive repairs in three or four years. Therefore, we say creosoted yellow pine block pavement is the most durable of all pavements."

Third. While wood block pavement is slightly more expensive as to first cost than asphalt, bitulithic or brick, its wonderful durability and ease of repairs soon enable it to overcome any saving as to first cost by other pavements.

In New York, Chicago, Cincinnati. Philadelphia, St. Louis, Detroit, Minneapolis, Indianapolis, Atlanta and Boston wood block paving costs from 33⅓ to 50 per cent. more than asphalt, brick or bitulithic paving, yet in the business districts wood block paving is used almost to the exclusion of the other pavements named.

If, in ten years, the other pavements are worn out and have to be replaced with some other pavement, and under the same climatic and traffic conditions at the end of ten years, the creosoted yellow pine blocks show no wear and are as good as when first put down, would they not be cheaper and more desirable as an investment were the first cost double that of the other pavements?

Constant repair of pavements is a fearful nuisance to the business men of a city, and holes in a pavement are productive of a multitude of damage suits, the expenses of which should be charged to the faulty pavement.

Fourth. We say creosoted yellow pine block pavement is the easiest and most economical of all pavements to repair and is the only pavement that can be effectually repaired and made to look as well after repairs as before. And to repair wood block paving requires no expensive outlay—only a laborer, a hatchet and a few blocks necessary for any wood block repair.

The blocks are more easily trimmed to fit than are bricks. Square cuts have to be made for brick repairs, while wood blocks can easily be made to dovetail into the pavement and the pavement made as good as when new. Therefore, we say creosoted yellow pine block pavement is the easiest and most economically repaired of all pavements.

Fifth.—On account of its smooth surface, elastic and yet unyielding so far as impeding traffic, it offers the least resistance to traffic of all other pavements the year round. Asphalt and bitulithic paving, when of smooth and regular surface, in winter offer as little resistance to traffic as wood blocks, but in summer, when yielding, the tires sink in and considerable resistance is encountered.

Sixth. Wood block paving offers a sure footing to horses when dry or wet, as shown by the long, easy strides they take on said pavement. When slightly damp from a heavy dew or light frost or heavy fog, when the pavement is not clean, like asphalt and bitulithic pavements, is slightly slippery for a short while early in the morning under those climatic conditions, but no more slippery than other smooth pavements under the same conditions.

Seventh. Wood block pavement, made of perfectly rectangular blocks, can be laid with a smooth surface and the wear or compression is perfectly regular. The interstices soon iron-out (weld together), leaving no receptacle to hold dust or impurities and is easily swept and, there being nothing to produce dust, we say wood block pavement is the cleanest and easiest kept clean.

Eighth. Wood block pavement is known as the "silent pavement." Wood does not reflect sound, has elasticity and yields under the horse's tread, does not give forth the metallic sound common to all other pavements.

This noiselessness has transformed the down-town districts of all our large cities. With wood block paving even the busy marts of London, Paris, Berlin, New York and Chicago are free from noise and clatter, which before proved so nerve-wracking.

First, second and third stories of buildings which have been abandoned as offices and sales rooms, after improvements of the streets with wood blocks become the choice office locations.

Ninth. Wood is the only material out of which a road surface can be made which possesses elasticity at all times.

On a wood block pavement a horse would never become "stove up." Examine your city horses and see the effect of all other pavements on them. You will find that in three or four years on asphalt, bitulithic, brick or granite blocks paving horses become stiff—"stove-up."

The saving on horses and vehicles on wood block pavement would, in a few years, amount to a sum sufficient to pave with wood blocks all the down-town streets in our cities.

Tenth. We have already stated that there is nothing about a wood pavement that can grind into dust under the erosion of wheels or the impact of horses' hoofs; while all other pavements, except brick, are made of materials which are ninety (90) per cent. dust producing, and brick we know to be of 100 per cent. dust producing materials.

Eleventh. We say it can be laid with a smoother surface than any other pavement, and the experience the past twelve years has proven, under heavy traffic, the wear or compression is uniform and the surface continues smooth.

As example, for instance, Tenth Street, Minneapolis; Tremont Street, Boston; Washington Avenue, St. Louis—the latter is so very smooth the children make it, after ten years' service under a heavy traffic, a skating rink; and of Tremont Street the street commissioner of Boston, late in 1912, wrote: "After twelve years' wear it looks as smooth as when first laid." Of Tenth Street, Minneapolis, Mr. George S. Harper, of said city, wrote: "The pavement on Tenth Street has been down ten years and it is in as good condition now as when laid." So with all our creosoted yellow pine block pavements; not so with any other pavement—all, without exception, wear unevenly into ruts and chuck-holes.

Twelfth. It is the least of all pavements affected by heat and cold; neither does moisture seriously affect it. In Minneapolis more than 60 per cent. of all the pavements are creosoted wood block paving. Altogether there are 61 miles, and every yard doing nicely, and some down ten years. In Chicago, Detroit, Indianapolis, Toledo, Cincinnati, Boston, New York, Atlanta, Mobile, Pensacola, Beaumont, Dallas, Kansas City, Mo., also in all the large cities of Europe, the pavements have given entire satisfaction; geographical locations or climatic conditions seem in no wise to affect it. We have testimonials from street officials in every city sustaining this declaration.

Finally. As before stated, the elasticity and smoothness of the wood block pavement cares for the horse, fully doubling his years of usefulness over any other pavement, and in turn the horse does no harm to the wood block pavement.

The same reciprocity exists between the creosoted yellow pine block pavement and the automobile.

The smooth surface of the wood block pavement does not whet out the tires; neither is there found on a creosoted yellow pine block pavement chuck-holes or ruts to bend the axles or throw out of adjustment the delicate parts of an automobile; nor are there slivers to puncture the tires—in fact, on a creosoted yellow pine block pavement, properly constructed, an automobile should last almost forever.

In turn, under automobile traffic, a wood block pavement should last almost forever. The friction between the tires and the pavement in no wise hurts the surface of the wood blocks.

The automobile is a machine of destruction to all other pavements, and in turn all other pavements wear out rapidly the automobile—the grit cuts the tires like an emery wheel; the chuck-holes and ruts bend the axle and throw out of adjustment and shake to pieces all the delicate parts of the machine.

If the creosoted yellow pine block pavement possesses all these good qualities, and in a superlative degree, why is it not an ideal pavement?

What is it lacking?

How can it be improved?

What is said against it?

Our competitors say "It is slippery." "It bleeds." "It buckles." "It is unsanitary," and "While creosoted yellow pine block pavement can be made a better pavement than any other, it is so hard to make right, and so easy to make wrong, that is is seldom a city gets a first-class job." And in their extreme lamentations they say, "It requires an army of carpenters to keep it in order."

As to these criticisms, let us see how many are real and how many can be remedied:

First. The bleeding is exuding of the heavy oil injected in the blocks under pressure for two purposes—to prevent decay and to lessen the absorptive power of the wood. The bleeding is positive proof that the blocks have been impregnated with the oil which the engineer said should be, and the inspector declares has been injected. No one has charged that bleeding is injurious to the pavement, except as a temporary nuisance which almost always begins and ends in the first hot season, and which can be made unobjectionable by whipping a thin coating of sand over the pavement two or three times during that period, which labor and expense fall upon the contractor, who is "both ready and willing."

The bleeding is not without its benefit; it helps to form a mastic coating around the blocks, which aids in preventing absorption.

Up to 1908 creosoted wood block paving did not bleed; blocks laid prior to 1908 were treated with oil of light specific gravity and treatment—1.04 to 1.08 specific gravity, and about twelve pounds of oil to the cubic foot of timber.

Since 1908 a heavier oil and treatment have been largely used—from 1.10 to 1.14 specific gravity, and from 16 to 20 pounds to the cubic foot of timber.

Whether about 1908 there was any material change in the mechanical treatment of the blocks we do not know.

The question of seasoned or unseasoned timber for blocks before treatment is an unsettled question.

Since every pavement made of creosoted yellow pine blocks, impregnated with from 10 pounds to 22 pounds of creosoted oil, the distillation, or the product of pure coal tar, with specific gravity from 1.04 to 1.14 has proven successful, and "not one has cost any amount worth considering for repairs," declared by every city engineer during their long service under heavy traffic, some more than twelve years, many miles more than ten years—who can say whether light or heavy oil, light or heavy treatment, seasoned or unseasoned woods, is the best and will be the most durable. We who have spent years studying the pavement have our preferences on all these points, yet none of us can prove our ideas are best. Since the blocks show no perceptible wear, no decay for twelve years under heavy traffic, on what are we to base our arguments?

If I am asked my preference on these points, I would say:

Let the oil be a pure coal-tar distillate, unadulterated by any other material whatever, with specific gravity not lighter than 1.06 and not heavier than 1.08; on distillation not to show more than 5 per cent. up to 210 degrees C. and not less than 45 per cent. nor more than 60 per cent. up to 315 degrees C.

For light traffic, 18 pounds; for medium heavy traffic, 16 pounds; for heavy traffic, 14 pounds to the cubic foot of timber.

Second. As to buckling. This has been a most awfully over-ridden hobby-horse. There is nothing that can happen to any kind of pavement so inexpensive and so easy to repair.

Either lay the blocks with tight joints, both longitudinal and transverse, as has been the practice in New York, with ample longitudinal expansion joint at the curbs, filled with a bituminous filler so compounded as not to melt below 175 degrees Fahr. or become brittle above 15 degrees Fahr.

This method will prevent bleeding, buckling and slipperiness and will make waterproof the pavement.

Third. As to slipperiness. Creosoted yellow pine block pavement is, as are all other smooth pavements, slippery under certain climatic conditions. If the pavement is not clean (covered with a film of dust or soot), and the morning is mucky, heavy fog or heavy dew, or very light sprinkle of rain, or light frost or snow, the pavement will be, for two or three hours, slippery. This condition will probably exist for two or three hours one day in every week the year through, and not more than that in any section of the United States. All of which can be overcome by an occasional whipping of coarse sand on the surface.

If the engineer will make the crown of his wood block pavement as light as the grade of the street will admit, and if above 4½ per cent. grade, will separate the blocks transversely with a creosoted strip ⅝ x 1 inch and fill the joint above the strip (the strip to be set up on the concrete base), with the bituminous filler, already described, and pebbles, there will be very little, if any, slipperiness, not any more than on asphalt, bitulithic, concrete or brick with cement grout filler under the same conditions.

Fourth. All creosote plants buy their oil in large quantities, and as fully 90 per cent. of the treating of timber and paving blocks is done under expert supervision, selected by those who pay for the work, the danger of imposition is reduced to the minimum.

As to the quality of the wood, any novice can tell whether it conforms to the engineer's specifications.

As to the construction work of the pavement, it is practically the same as that of several other pavements—so, where can the deception be practiced?

Fifth. As to the sanitation of the pavement, proof sufficient has already been given.

Sixth. As to the extent of repairs, we have shown that no expensive plant or gang of trained laborers are necessary to be maintained for said purpose, but the only thing needed is a laborer, a hatchet and a few new blocks.

What Improvements Can We Suggest?—I think we are on the "right line,"—will only mention a few points which, after long experience, much study and many critical inspections, have impressed me as essentials.

First. Be careful in making the Portland cement base. Have the ingredients carefully selected and well mixed; proportion depth to traffic, and always finish the concrete base with a template and straight-edge, exactly parallel to the contour and grade of the finished pavement.

As to cushion for the blocks, I prefer the mortar bed—of one part cement and three parts screened sand, mixed dry, struck off with a template and dampened with a hand-sprinkler just in advance of the paver.

Lay the blocks close-jointed sidewise and with one-eighth inch joint between ends of the blocks, carefully spaced.

At the curbs provide an inch expansion joint for a thirty-foot street, between curbs, and 1½ inches for a 50-foot street.

Have no transverse expansion joints on the pavements.

Trim the blocks to fit neatly around manholes, catch-basins and all permanent fixtures; provide necessary expansion joints around same.

Let the blocks be brought to a firm bearing by means of a hand-rammer in the hands of an active, careful laborer, or quickly rolled with a light tandem roller, from three to five tons.

After the blocks have been spaced, inspected and low blocks brought up to grade, the surface should be swept broom clean and a bituminous filler, so compound as not to melt below 175 degrees Fahr. or become brittle above 15 degrees Fahr., heated until as thin as water, should be poured on the surface and worked back and forth with a squeegee until all cracks, interstices and expansion joints are three-quarters full, using sufficient force on the squeegee to leave only a thin coating on the surface of the blocks, into which, while hot, sprinkle a layer of pebbly sand.

Traffic should be excluded for at least four days, and longer if necessary, for the mortar bed to properly harden.

If a sand cushion is used, let it be only one-half inch in depth, made of screened sand not too fine.

This plan should be used universally on bridge floors.

What Should Not Be Done.—Blocks should not be loosely laid on a sand cushion, varying from ½ inch to 2 inches in depth and a sand filler used—remember, wet sand is as unyielding as granite. You could with equal propriety each day drive steel wedges between the blocks. As the blocks shrink the sand trickles down to fill the space made and keeps the blocks hugged in this narrowest limit. When the blocks are wet so also is the sand, and when the blocks want to expand to their natural sizes, the wet sand will not yield and a buckle of the block occurs.

If sand is to be used as a filler, lay the blocks close-jointed both longitudinally and transversely, and place a half-inch layer of coarse, pebbly sand on the surface.

Neither should a paving pitch filler be used unless specially made for the purpose, guaranteed not to melt below 175 degrees Fahr. or become brittle above 15 degrees Fahr.

Ordinarily paving pitch on a wood block pavement is a nuisance in hot weather, and below 50 degrees Fahr. it is absolutely unyielding. Wood blocks will want room for expansion below 30 degrees Fahr.

As to Treatment.—The period should not be too short—making haste is dangerous; gradual heat, not at any time to exceed 240 degrees Fahr., rapid vacuum up to 22 to 26 inches of mercury—slowly increasing pressure not to exceed 200 pounds.

Better retain 150 pounds pressure longer than hasten the work by applying 250 pounds pressure for a shorter time.

As to Timber.—Like the specific gravity of the oil, too much of a bugaboo is made of the amount of heart lumber to require. We have diligently searched for evidence to prove that sap in creosoted wood blocks wear more rapidly than heart, and not in one instance have we found such evidence.

The blocks, if laid level on a concrete foundation with close joints, the compression or wear has been perfectly regular, as much on the heart side as on the sap side.

The treatment seems to toughen the timber, making the heart and the sap of equal wearing surface in paving.

Therefore, we say there is no good accomplished in calling for 66 per cent. or 95 per cent. of heart. Such requirement adds considerably to the cost of the timber. Our mill men are anxious to sell heart lumber, but they greatly increase the price charged therefor.

Square-edged and sound Virginia southern yellow pine, free from all defects which would injuriously affect the timber for the uses intended, are all that is needed in an up-to-date, first-class timber specification for paving blocks.

With these precautionary suggestions as to timber classifications, treatment and construction observed, we will have in the creosoted yellow pine block pavement the ideal pavement.

COAST TO COAST.

Vancouver, B.C.—The contract for the building of the new police headquarters has been awarded to Mr. C. F. Perry, his tender being for $250,000.

Montreal, Que.—Canada has now 26,727 miles of railroad in operation, and 3,466 miles under construction. Gross earnings of Canadian railroads in 1912 increased 16.2 per cent.

Winnipeg, Man.—A report issued by the highways commissioner for the province of Manitoba shows that a sum of over $1,000,000 will be spent during 1913 on the highways of the province.

Montreal, Que.—The Montreal Trust Company estimate the total output of the Cedar Rapids plant, when completed, to be 100,000 horse-power This would mean an annual revenue of $3,500,000.

Montreal, Que.—Mr. George Janin, in his report to the Board of Control, estimated that it will cost three and a half million dollars to pave streets and sidewalks that are not paved now within a radius of two miles of the city hall.

Minneapolis, Minn.—The Minneapolis, St. Paul and Sault Ste. Marie Railroad will spend $25,000,000 in building 725 miles of new road, which will cross Montana and strike the Canadian Pacific road somewhere near the Montana-Idaho boundary line.

Hamilton, Ont.—The council has decided to contribute $25,000 towards the construction of the proposed concrete highway between Hamilton and Toronto, provided the Ontario government builds and maintains the new road starting where the asphalt pavement ends at the cemetery gate.

Guelph, Ont.—County Road Superintendent J. M. Young reported that the amount of money spent under the Highway Improvement Act for road and bridge construction from November 16th, 1911, to December 31st, 1912, was $33,597.38, of which $13,242.38 was for bridges and $20,355 for roads.

Sault Ste. Marie, Ont.—The H. E. Talbott Company of the Soo, have been awarded the contract for the construction of a 1,500 foot dam and the installation of a complete hydro-electric system at Grand Mere, Que. The contract involves a sum of over a million and a half and 1,000 men will be employed on the work.

Vancouver, B.C.—The province of British Columbia stands third among the provinces in the Dominion in amount of articles manufactured, producing $65,204,235 worth of goods; and fifth in the cities of the Dominion in the rate per cent. of increase of values of products with 695.16 per cent. for 1910.

Victoria, B.C.—Mr. W. Fleet Robertson, provincial mineralogist, has completed a preliminary review and estimate of the mineral production of the province of British Columbia for the year 1912, which sets the total value of the production for the past year at $32,606,000, or $9,106,928 in excess of the production for 1911.

Calgary, Alta.—Mayor Sinnot has submitted an estimate to the city council, providing for a $10,000,000 pipe line from Bow Island to Calgary and neighboring points, to be controlled by the municipalities and retailed at cost to manufacturers and other consumers. The Bow Island town council is preparing to operate municipal gas wells and furnish this natural fuel free to manufacturers locating here.

Hamilton, Ont.—Jas. Bain, electrical engineer, in his report shows that during the four months the two electrical pumps were in operation the cost per million was $6.35, while during the eight months coal was used the cost was $7.01. With the combined use of electrical power and coal, however, the average cost per million gallons was $5.23, the net saving by the use of steam to keep down the peak load being $1.11 for every million gallons.

Sarnia, Ont.—The Huron Lake Shore Railway, with a capital of one million, are seeking a charter to construct not only a railroad from Sarnia to Seaforth, but also a line of steamboats is contemplated by the company, which will mean the building of wharves, warehouses and other adjuncts of marine shipping. Telegraph and telephone service will also follow the line of the railroad. It is understood that hotels, pleasure resorts along the proposed route are possibly to be included in the plans of the company.

St. Thomas, Ont.—The City Council have awarded the contract for the construction of the new Just Wright shoe factory to Albert E. Ponsford, his tender for the complete work being $33,953. Other contracts in connection with the work are as follows: Sprinkling system, to cost $3,100, the General Fire Equipment Company of Toronto; vault doors, costing $56.25, Ford & Fetherston, of Hamilton; electric elevator, $520, will be supplied by the Otis-Fensom Company. The factory, complete, will cost $37,629.25.

Hamilton, Ont.—Articles incorporating the International Harvester Corporation, with an authorized capital of $70,000,000, was filed with the secretary of state at Trenton, N.J., the incorporators being connected with the International Harvester Company, a concern already chartered under the laws of New Jersey with an authorized capital of $140,000,000. The new corporation has been formed for the purpose of taking over the business and properties of the International Harvester Company in foreign countries, including the manufacturing plants in Canada, France, Sweden, Germany and Russia.

VANCOUVER BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the annual meeting of the Vancouver branch of the Canadian Society of Civil Engineers, held on 20th January, 1913, the following officers were elected for the ensuing year: Chairman, G. E. G. Conway; vice-chairman, L. G. Robinson; secretary-treasurer, F. Pardoe Wilson; executive, C. E. Cartwright and W. A. Clement. Secretary's address, 422 Pacific Building, Vancouver.

ALBERTA ARCHITECTS' ASSOCIATION.

The annual convention of the Alberta Architects' Association was held January 23, 24 and 25, at the Edmonton Board of Trade Rooms, Edmonton, Alta. The following officers were elected for the coming year: President, R. W. Lines, Edmonton; hon. president, G. M. Lang, Calgary; 1st vice-president, Jas. Henderson, Edmonton; 2nd vice-president, J. J. O'Gara, Calgary; hon. secretary, W. D. Cromarty, Edmonton; hon. treasurer, G. H. McDonald, Edmonton. The following is the newly elected council: R. P. Blakey, Edmonton; L. Gibbs, Edmonton; Geo. Fordyce, Calgary; W. S. Mayor, Calgary, and R. P. Barnes, Edmonton.

MEETING OF THE SOCIETY OF CHEMICAL INDUSTRY.

A largely attended meeting of the Society of Chemical Industry was held last week in Montreal. Prof. R. F. Ruttan was in the chair. The lecturer of the evening was Mr. James O. Meadows, superintendent of the filtration plant of the Montreal Water and Power Company, who spoke on "Water Purification," with special reference to rapid sand filtration. In the course of his lecture he described various forms of chemical and mechanical filtration, and referred to the systems being installed for Montreal and suburbs. The lecture was followed by an interesting discussion.

PERSONAL.

SETON PORTER has been admitted as a member of the firm of Sanderson & Porter, consulting engineers, New York.

RICHARD S. BUCK has retired from the firm of Sanderson & Porter, of New York, and has become chief engineer of the Dominion Bridge Company, of Montreal.

GEORGE CRAIG, assistant city engineer of Omaha, Neb., has been appointed city engineer of Calgary at a salary of $5,000 per annum.

W. A. OSTROM, chief engineer of the power house, Saskatoon, Sask., has resigned his position and will become general erecting superintendent of the General Electric Company west of Winnipeg.

LEE MURRAY, M.C.E. (Melb.), M.Inst.C.E., M.I.E.E., M.I.Mech.E., who recently retired from the position of general manager of Messrs. Bruce Peebles & Company, Limited, engineers, Edinburgh, has started business on his own account in London as engineering representative (buying, inspecting, etc.) for firms and corporations in the colonies and abroad. Mr. Murray's address is 10 Norfolk Street, Strand, London, W.C.

PHELPS JOHNSON was born in Orange County, U.S. From 1872 to 1879, Mr. Johnson was engineer for the Hawkins Iron Works, at Springfield, Mass. In 1879 he became assistant engineer for the Wrought Iron Bridge Company, of Canton, Ohio. In 1882 he came to Toronto as engineer and manager of the Toronto Bridge Company, which afterwards became the Dominion Bridge Company. In 1888 he became chief engineer of the Dominion Bridge Company, at Lachine, P.Q., which position he retained until 1892. In 1892 Mr. Johnson was appointed general manager of the Dominion Bridge Company, which position he holds to-day. Mr. Phelps Johnson is also president of the St. Lawrence Bridge Company, which company was formed to construct the steel superstructure of the new Quebec bridge. Mr. Johnson is a member of the St. James Club, the Engineers' Club and the Royal St. Lawrence Yacht Club of Montreal. Last year at the annual meeting of the Canadian Society of Civil Engineers he was elected a member of the council.

Phelps Johnson, the New President of the Canadian Society of Civil Engineers.

RAY R. KNIGHT has received the appointment of city engineer of Fort William. Mr. Knight, who is an associate member of the Society of Civil Engineers and associate of the Institution of Municipal and County Engineers, is at present chief designing engineer in the sewer department of the city engineer's office, Toronto. During the two years he has held this position he has been responsible for the design and planning of sewerage schemes and storm sewers to the value of nearly $4,000,000. In addition to this he was called upon to report and give estimates for the disposal of the house refuse of Toronto involving an expenditure of $900,000. Before coming to Canada, a little more than two years ago, Mr. Knight was deputy town engineer of Bromley, England, and for five years previously held a similar appointment at Wood Green, London, England. Special street railway and sewerage work occupied his time before this at Folkestone, England. He was articled to the town engineer, Carnarvon, North Wales. For nearly sixteen years Mr. Knight has been engaged in municipal engineering in every phase, including many large sewerage, street railway, roadway and waterworks undertakings.

FRANCIS C. GAMBLE, the new vice-president of the Canadian Society of Civil Engineers, is the second son of the late Clark Gamble, K.C. He was born in Toronto, on October 23rd, 1848. His early education was received in Upper Canada College and by private tuition. He began his engineering career on the Intercolonial Railway in 1869. In 1872 he was assistant engineer on the Canadian Air Line (Great Western Railway), subsequently he became resident engineer for the contractors on the P.E. Railway. He was assistant engineer for the Intercolonial Railway, the Q.M. & O. Railway, and the Canadian Pacific, at Rat Portage, during construction. In 1880 Mr. Gamble was sent to British Columbia as assistant engineer on Government work above Yale, B.C. He was afterwards transferred to the Department of Public Works of Canada in British Columbia. In 1887 he was appointed resident engineer in the province which position he resigned in 1897 to become public works engineer and inspector of dykes for the province of British Columbia. In 1911 he became chief engineer and inspecting engineer of Railways for British Columbia. Mr. Gamble was elected a member of the society in 1887. He is also a member of the Institute of Civil Engineers, of London, Eng., and of the American Society of Civil Engineers.

Mr. Francis C. Gamble, Vice-President of the Canadian Society of Civil Engineers.

S. BRUCE McCONNELL, Assoc. M. Can. Soc. C.E., formerly assistant division engineer of the Canadian Pacific Railway, at Montreal, Que., has been promoted to be assistant engineer. His headquarters will remain at Montreal. Mr. McConnell entered the railway service in 1898 as a transitman on the location of the Midland Railway of Nova Scotia.

Later he was transitman and resident engineer on construction of the Great Northern Railway of Canada, and resident engineer of a railway in Cuba. He joined the engineering staff of the Canadian Pacific in 1902, as assistant engineer in charge of yard construction at North Bay, Ont.

MAJOR W. W. CROSBY, M.Am.Soc.C.E., chief engineer to the Maryland Geological Survey, and consulting engineer, Baltimore, Md., on January 31st delivered an illustrated lecture on "Engineering Duties and Responsibilities," before the graduate students in Highway Engineering at Columbia University.

OBITUARY.

JULIAN THORNLEY, M. Am. Soc. C.E., died in the Masonic Hall Building, New York City, December 28. He was 44 years old, was formerly an engineer with the New York State Water Supply Commission, and was at one time resident engineer on the construction of the plant of the Electrical Development Company at Niagara Falls, Ont.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Fourth Regular Meeting. Toronto Section, will be held at Engineers' Club, 96 King Street, West, 8 15 p m , Friday, February, 7th, 1913. Secretary, H. T. Case, 611 Continental Life Building, Toronto

UNIVERSITY OF TORONTO ENGINEERING SOCIETY.--Meeting on Wednesday afternoon, Feb. 12th. Illustrated lecture by Mr. David Molitor of Engineering Staff of the Panama Canal. H. Irwin, Secretary.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March. 3, 4 and 5, 1913, in the Green Room, Congress Hotel and Annex, Chicago, Ill. Secretary, Will P. Blair.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod

KINGSTON BRANCH—Chairman, A K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa: Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos: meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James: Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway: Secretary-Treasurer, F. Pardn Wilson, Address: 422 Pacific Building, Vancouver B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary R. W. MacIntyre: Address P.O. Box 1290

WINNIPEG BRANCH—Chairman, J. A. Hesketh: Secretary, E. E. Brydone-Jack: Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—P ident, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O , Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Feb. 13, 1913

Contents of this issue on page 307

The Canadian Engineer

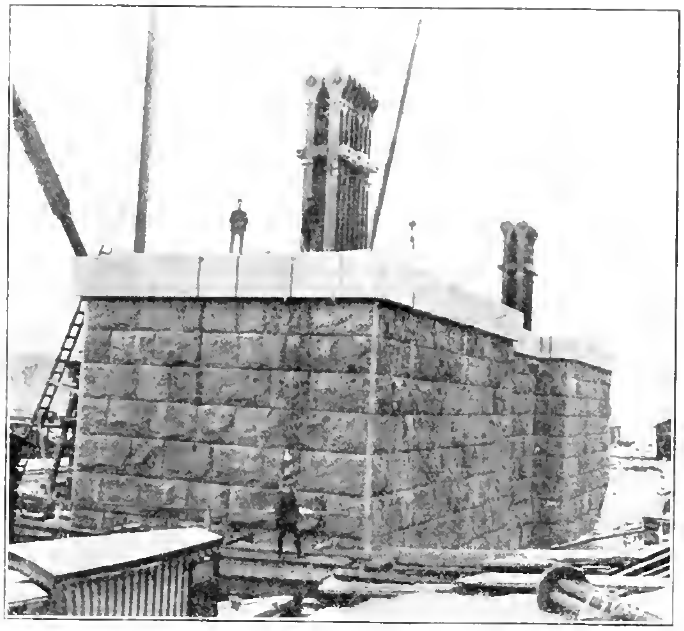
An Engineering Weekly

PROGRESS IN CONNECTION WITH THE CONSTRUCTION OF THE QUEBEC BRIDGE.

Very satisfactory progress has been made in connection with the construction of the huge Quebec bridge, situated some seven miles above the city of Quebec.

The contract for the substructure was let in January, 1910, and the contract for the superstructure in April, 1911. The work on both contracts has gone ahead as rapidly as possible since these dates, and at the present time there are material evidences to prove that before very long the River St. Lawrence will be successfully spanned by the largest bridge in the world.

Owing to the increase in weight and width of the superstructure, the piers of the old bridge had to be removed and new ones constructed in their place. All the more difficult work in connection with the substructure is now practically completed. The caissons for the north and south main piers have been sunk to the required depth, that for the nortn pier about 50 feet and that of the south about 85 feet below the bed of the river. All the rest of the work in connection with the substructure is above high-water mark or protected from the water, and presents no serious problems. The masonry involved in this contract includes alterations to the existing abutments and the entirely new construction of one intermediate pier, two anchor piers, and two main piers. The total yardage in these various pieces of masonry amounts approximately to 105,000 cubic yards. The timber used in the caissons is mostly 12-inch by 12-inch long leaf southern pine, and some 18,000,000 feet B.M. were used in the construction. The piers on the north side of the river are well advanced, and will be ready to accommodate the steelwork early in the coming season.



View Showing North Anchor Pier with Eyebars Extending Above.

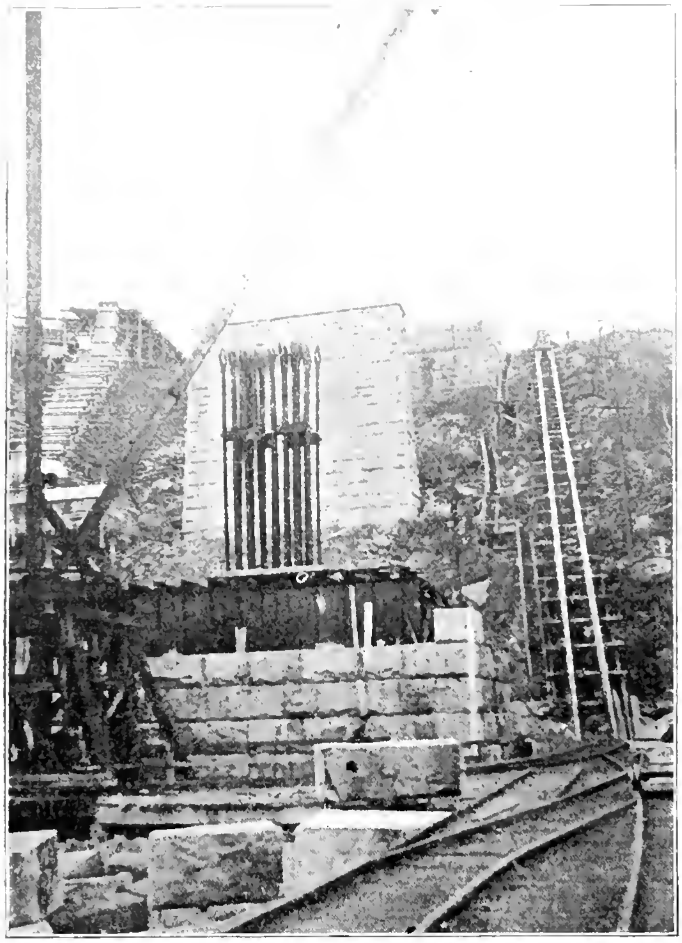
This pier will be extended 100 ft. higher than is shown here. Some idea of the enormous size of the stones can be gained by comparing with men in the picture. Dec. 2nd, 1912.

Since the awarding of the contract for the superstructure, the contractors, the St. Lawrance Bridge Company, of Montreal, have had a staff of between thirty and forty men engaged in their offices working on the detailed plans of the design. The design, details and problems in connection with this bridge are to a large extent without precedent, and as a result much time has been spent in investigation and studies that would not have been necessary with a smaller structure.

Plan after plan has been made, studied and revised, no detail of construction or calculation being too insignificant to court the minutest investigation. The contractors work in conjunction with the designers and calculators of the board of engineers, and no detail was passed unless thoroughly approved by both. Entirely independent sets of calculations were made by the board of engineers, each calculation being checked and re-checked independently so that there could be no possibility of error creeping in. Therefore, each simple calculation was subjected to two independent investigations by the contractors and two independent investigations by the board before it was finally approved. The suspended span was first designed and shop drawings completed from which the actual dead loads were computed before starting on the cantilever arm, which is in turn being completed before the drawings of the anchor arm are made. It can therefore be seen that there can be no chance of over-run in dead weight in the completed structure, as was the case in the old bridge.

The enormous proportions of this bridge cannot be properly appreciated until actually viewed in place. Some idea, however, may be gained from the following facts:—The completed bridge will probably exceed 50,000 tons of steel, equivalent to 1,700 carloads of 30 tons each, or over 500 train loads of 30 cars each. While this is an enormous quantity of steel to go into any one structure, yet there would be no difficulty in handling it were it manufactured in the ordinary commercial sizes used in bridges and structures to which we are accustomed. The great difficulty of the mechanical side of this enterprise arises from the fact that nearly all the members of the bridge are of such enormous proportions that the ordinary shops or equipment are entirely inadequate to manufacture or handle them. Shops with columns and girders of unusual strength are required to carry the heavy cranes which handle the enormous members. Almost every piece of machinery used must be of the largest capacity, and in the majority of cases are specially designed for this job.

The main posts of this bridge are about 10 feet by 10 feet in outside area and approximately 320 feet high, or equal to the height of a thirty-story building. The shoes on the main pier upon which each of these posts rests are 21 feet by 26 feet square and 15 feet high. Many a family lives in a house



View Showing Lower Anchorage, Girders and Eyebars in Place.

(Also completed intermediate pier and abutment in the background).

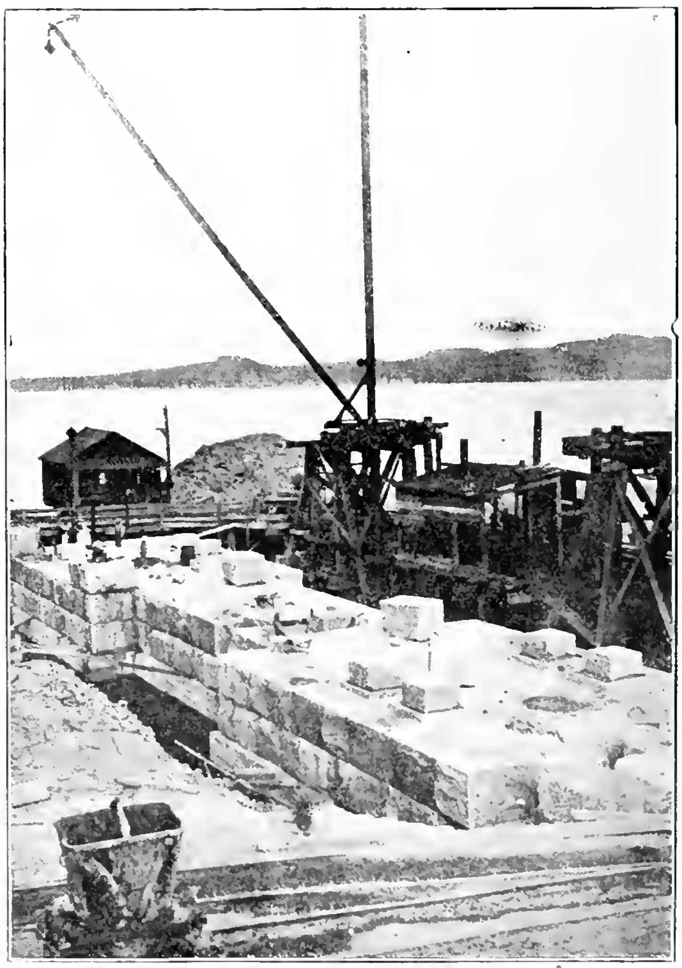
considerably smaller. The main bottom chord near the pier is about 10 feet wide and 8 feet high. If it were not for the interior webs and diaphragms six men could walk abreast inside this chord without crowding or fear of hitting their heads. This chord will weigh about 8,500 lbs. per lineal foot and is erected in sections weighing from 75 to 100 tons each. The main floorbeams are approximately 90 feet long and 10 feet deep, and weigh between forty and fifty tons. In most cases they are connected to the truss by pins in order to do away with the secondry stresses in the posts. The top chords of the cantilever and anchor arms are composed of two banks of eyebars of half panel lengths, and are supported by light Warren trusses between main panel points.

The floor system is designed to carry two railway tracks and two sidewalks for pedestrians. No allowance is made for highway traffic.

Elaborate preparations are being made by the contractors for the erection of this steel work. Erection will be carried on on both sides of the river simultaneously, which means a duplicate erection plant throughout. While this entails somewhat more expense for the contractors it will be justifiable by the saving of time. The anchor arms will be erected on heavy steel falsework which is so designed that the trusses will be carried on falsework independent from that which carries the traveler. The main traveler will be an enormous structure about 200 feet high and weighing, inclusive of hoisting machinery and tackle, about 900 tons. The traveler is constructed with an overhang from which heavy blocks are suspended and operated by means of electric hoists. Each hoist is capable of lifting 50 tons simultaneously, 60 feet beyond the point of support. The traveler is also equipped with cross gantrys and electric cranes and enormous booms which can handle material in practically every position. The blocks for the dozen or more hoists used in this traveler have all to be specially designed and constructed, many of them being over 5 feet in height and weighing over 5,000 lbs. each.

Probably one of the most interesting features of the erection will be the floating in of the 640-foot centre span. By means of this scheme of erection the difficulty of joining up at the centre is overcome and one year saved in the erection of the bridge.

While the floating in of a bridge span is a common enough occurrence to bridge erectors, yet, taking into consideration the length, weight and height of this span, and also the fact that there is a seven or eight-mile current and a 20-foot tide at this point, it can be seen that this part of the work is also without precedent. It is proposed to erect this span on steel falsework or staging on the shore or in shallow water at some point near the bridge site. This falsework is founded on concrete piers so spaced as to allow pontoons to



Starting Construction of the North Anchor Pier.

(View shows granite bed rock in place upon which steel anchorage is to be placed. Sept. 11, 1912.)

float in between them and under the falsework. When the span is completely erected and ready to be floated, the pontoons are placed in position under the falsework when the tide is low. As the tide rises the pontoons lift the bridge off the concrete piers. After the span has been towed to its

proper position under the bridge it has yet to be lifted over 130 feet in the air and connected to the ends of the cantilever arms. This is done by means of hangers with slotted holes which can be quickly attached to the four corners by means of pins. After this has been done at highest tide the pontoons are floated from under and the span is lifted in place by jacks at each corner of the cantilever arms.

View Showing North Main Pier.
(Completed up to high water mark and the caisson removed. Nov. 8th, 1912)

Entirely new shops have been constructed by the St. Lawrence Bridge Company, of Rockfield, near Lachine, and manufacturing has just been started. This shop is completely equipped with the latest and most powerful electrically driven machine tools, and will have a capacity of about 2,000 tons a month.

The supervision of the entire work is under the direction of the board of engineers appointed by the government. Mr. C. N. Monsarrat is chairman and chief engineer, with whom are associated Mr. C. C. Schneider, of Philadelphia and Mr R. Modjeski, of Chicago.

THE PRINCIPLES OF SCIENTIFIC MANAGEMENT.

On the occasion of his visit to Toronto to address the Canadian Club, Frederick W. Taylor, M.E., gave an address on "The Principles of Scientific Management" to the Engineering Society of the University of Toronto, on January 21st, 1913.

In his opening remarks Dr. Taylor presented his subject as referring principally to workers of co-ordinated industry, in distinction to isolated workmen, it being applicable only to the former.

Nineteen of every twenty workmen believe that it is to their best interest to turn out as little rather than as much work as possible. It is the most serious fallacy that possesses our working class, and is attributable to two causes, for neither of which are the workmen themselves to blame.

First, if it be suggested to a group of workmen that they double their output, they reply that the procedure would throw one-half of their fellow-workers out of employment. To them it appears self-evident, and others, among whom are many of our philanthropists, uphold the belief, heralding over-production as one of the greatest social evils conducive to national idleness. It is immensely true in every trade, so its followers believe, that in going slow, their interests are advanced. Any device, therefore, tending to increased output is rebelled against by this deeply rooted nature.

No more fallacious than such belief exists, and it is borne out by history everywhere, with but one exception, that the introduction of such a device or system, into any trade, instead of forcing men out of work, has provided more work for men of that trade The exception is in farming. Improved processes in the United States have reduced the providers of food supplies from eighty per cent. in years past to thirty-five per cent. at the present time, because the human capacity for food does not increase from generation to generation. This is the only instance where such a condition obtains.

As an illustration of the effect in other forms of labor, Dr. Taylor referred to the cotton industry, its history being comparatively older and its evolution more spectacular. The power loom was invented early in the last quarter of the eighteenth century, but the year 1840 witnessed the climax of its introduction, after a struggle many years in duration, to gain entrance into the manufacturies. In Manchester, Eng., the workmen felt that these looms would throw 3,500 of their 5,000 men out of work, and they strongly resented such outside intervention between them and their daily bread. Conditions were grave, as it was most difficult in those days to change one's trade, or even to move from one works to another. No alternative means of livelihood presented itself. The result was clear and concise. They forced the establishments, destroyed the looms, and maltreated the operators. Their rioting, however, did not affect the entrance of the loom into the industry.

Be the means what it may, bitter opposition, adverse legislation, public opinion, trade unions—all forces are powerless and futile in defeating the introduction of labor-saving development, and the effect is frequently that of accelerating its use.

The speaker stated that there is great opposition from labor leaders to scientific management, but since that opposition has become open and strong, scientific management has gone ahead more rapidly.

The result in the case of the cotton industry in the three-quarter century that has elapsed has been that the workmen have been proven wrong in their convictions. Has the increase of output thrown laborers out of work? In 1840 there were 5,000 workers. At the present time there are about 265,000 employed at the same work in Manchester. For every yard of cloth in 1840 there are now five hundred yards manufactured, though the population of England has not more than doubled within that time.

"There is a broad meaning back of it all. Wealth need only be brought into the world, for the world to use it. Although there are undeniable cases of over-production, they are abnormities, due to a general cause—the world undertaking a greater number of new enterprises than available capital warrants. It is a disease to which the public is susceptible, and the panics of 1873 and 1893 are unforgotten. On the other hand, production is necessary to wealth, which is derived from two sources, viz., out of the ground and by manufacture at the hands of man. The relation of wealth to production should be recognized, particularly by the poorer classes; their impression is erroneous that by far the major

part of the bounties of this world are consumed by the wealthy classes. The reverse is the truth.

"The best index of progress in the world is the increase in output per individual, it being a measure of the increase of prosperity of the individual. The 'good old times' slogan indicates the user to be ignorant of conditions, as increase in output per man has provided such a variety of good things of life that the workmen of to-day live as the kings of yesterday. Luxuries of history are considered necessities now."

Reverting to the previously discussed condition in the farming industry, apart from those who provide the food supplies in the United States, sixty-five per cent. of the population may now engage in other industries as against the twenty per cent. years ago. This indicates increase in output per individual, which is the object of scientific management.

The second belief the workman entertains as a reason for going slow, Dr. Taylor emphasizes as being again in no way attributable to the man himself. It is illustrated by the case of a workman being paid $2.50 per day and making 10 pieces a day, entering then upon the piece-work system. The foreman pays him twenty-five cents per piece for the ten pieces which he turns out. Gradually the laborer increases his output, probably reaching twenty pieces per day, thereby doubling the contents of his pay envelope. Both laborer and foreman are well satisfied with the result.

But at the annual meeting of the board of directors, the pay-roll may properly be called for and closely examined. The foreman must explain his action in paying $5.00 per day instead of $2.50 per day. A storm of protest ensues, savoring of competitors' prices and pay-rolls, and resulting in measures to prevent the supposed ruin of the firm's labor market. The foreman is obliged to reduce the workman's salary to perhaps $2.75 per day.

"There are a great many bitter things said against the workingman, concerning his selfishness, his tyranny, etc.; some of them are true, but there is just one thing that the working man of our country is not—he is not a fool. It is only necessary to give him one lesson, or at the most two, and he becomes a 'soldier' for life. He studies just how much the management will permit him to earn, and that is the amount of his output."

The fallacy of going slow is of such vital importance that the evil of it cannot be pointed out too strongly. There is not the slightest doubt that this is the greatest evil of the age in England She is suffering from under-production, not over-production, and no voice is raised in protest. England preceded this continent by a generation in the adoption of the policy of "soldiering," and the result has been detrimental in the reputation of the working man hailing from her shores, although he is, especially the steel worker, the most skilled workman in the world. The speaker cited cases where the laborer from across the seas absolutely refused to increase his output, curtailing it at every turn, thus necessitating drastic measures against his employment. The same thing is going on in England to-day and is the reason for unemployment and poverty. The policy of curtailing output strikes at the very root of the trouble.

"The first step of scientific management was to endeavor to prevent this diminishing output, and each succeeding step has been an earnest endeavor to remedy other existing evils in previous forms of management. Scientific management is no new or untried theory, and is no food for profound suspicion. It is a gradual evolution tested and proven step by step. It is the fruit of many men's ideas. Some years ago over fifty thousand men were working under its principles while the number has probably doubled since that computation was made.

"As in the case of all labor-saving devices, the ultimate result is that the general public gets the entire profit. The end of it all is that the whole world is going to profit from it. At first the companies that have introduced it are reaping large profits, many of them more than doubling their output. They are the pioneers, and as such are entitled to the gains."

A workman under scientific management immediately increases his wages from 33 to 100 per cent. This increase is not the greatest good to the working people, however, but the change of mental attitude toward work on the one hand and employers on the other is a more important part of their lives. They have changed from war to peace. There is now co-operation for the same object. The old suspicious watchfulness is supplanted by confidence, peace, conscientious work, and, on the whole, a feeling of satisfaction and pleasure that the employers are profiting as well as themselves. Scientific management has been introduced in almost every department of industry, and in the thirty years in which it has been thriving there has not been a strike in a place where it has been in force, although scores of strikes have occurred in other and similar works.

"It is not any efficiency device for increasing output; it is not a bonus system; it is not a cost system; it is not motion study, or time study; it is not unloading a lot of blanks at the goods entrance and saying, 'There is your system, go ahead and use it.' Most people think of it as one of these things. Scientific management cannot and does not exist until there has been a complete mental revolution on the part of the workmen and the employer, and until this great and complete mental revolution has taken place, scientific management does not exist."

Part of the cost of manufacturing is the cost of material. Another part is the cost of production of the article, and a third is the overhead expense. The difference between the sum of these three and the selling price is the surplus. All labor troubles are due to the division of this surplus. The workmen desire as much as they can get in the form of wages, etc., and the owners as much as they can get in the form of dividends. Under scientific management they have ceased combat over the division of this surplus. The result has been a surplus so large that both contenders get more than they ever received before. The workmen get at least 33 per cent. more wages, and the company gets larger profits. This is one result of the mental revolution.

Dr. Taylor pointed out forcibly the delusion almost universal among workmen that the division of the surplus in the past has been entirely wrong; that the working men are not getting their proper share of the general profits of capital and labor. Although in some cases it is true, their feelings have been rashly augmented by the labor leaders, newspapers and the public. In an article on "Division of Capital," in the Atlantic Monthly of June last, Norman Faig showed their conviction to be wrong. All that the working man can ask for is that the profits that accrue to capitalists should come to the people of the United States. They themselves could not demand all this profit. If it should be divided in the manner suggested there would be thirteen cents per day per man as dividend. It shows conclusively that the hope of the workman does not lie in the division of capital. It lies rather in an increase of output.

The speaker outlined the older type of management where, for example, 500 to 1,000 men in perhaps twenty different trades, have acquired their knowledge, not by books, but by observation and by traditional word of mouth. This is just the condition that obtained in the middle ages, and still largely obtains. Yet, in spite of lack of progress his trade is the workman's greatest asset. To achieve the best results one realizes that he must get the initiative of his workmen, but one's realization of "soldiering" forces him to the conclusion that to render this initiative the workman must receive a larger remuneration than his competitors.

The employer who has the pluck to do this, and to continue doing it, will find that his men will respond to such good treatment. This is the highest type of management under the old system, yet it cannot compete with scientific management, for under the latter there is no spontaneity on the part of the workman, but continuous effort. This, because of the new and unheardof burdens which the management assume.

The first of these principles is the gathering-in of the great mass of traditional knowledge held by the workmen; recording it, and reducing it to laws, rules and mathematical formulas. These deductions become of immense assistance in increasing the output. Rule-of-thumb knowledge is replaced by science.

Secondly, it becomes the management's duty to study carefully every man in the plant, his capacities, possibilities and limitations; and to train each to the highest class of work for which he is shown to be fitted—progressive selection and progressive study.

Thirdly, the science and the scientifically trained man are brought together. This is difficult. It can be accomplished only by binding the workman to work by science. This, however, does not cause appreciable trouble. Nine-tenths of the trouble experienced comes from forcing the management and owners to assume their burdens.

And, fourthly, a great mass of work formerly done by the workmen is now partly taken over by the management, until the whole is more equally divided. On the management's side there is generally one man for every three workmen.

These principles are deduced from years of study and work under scientific management. The system is no longer something which might be found beneficial if tried—it has been well tried—and pays.

To illustrate the application of the principles of scientific management, Dr. Taylor chose the operation of shovelling. A careful study and series of observations in a plant where four hundred to six hundred shovellers were employed resulted in a reduction in the cost of handling iron ore from eight cents per ton to less than four cents, after paying the workmen employed 60 per cent. higher wages, establishing a labor office, employing teachers to instruct the men how to scientifically handle a shovel, and timekeepers, etc., to record performances.

Investigation showed that the loads upon shovels under old methods varied from three and a half to thirty-eight pounds. Placed on a scientific basis, a load of about twenty-one pounds to the shovel, proper motions, simple and untiring, the work was now being done by 140 men. Furthermore, investigation into their private affairs showed the workmen to be living better lives, in every way, than before.

Illustrations were also given in the operation of machinery. The speaker claimed that not one in fifty of the machines in the factories of America are speeded accurately. The majority of them are 200 per cent. to 400 per cent. out, and from two and a half to nine times as much work could be done by them if they were properly adjusted. In the work of the high-class mechanic science is so great a factor that he cannot gain the proper knowledge of himself.

Dr. Taylor instanced, in closing, a case in machine manipulation where mathematicians were confronted with a problem involving twelve unknowns, and struggled with it for eighteen years. Now the problem is solved in twenty seconds on a slide rule taking care of the twelve variables.

"If you are willing to pay the price in time and hard work, things that have through the ages been termed impossibilities, can eventually be solved and put to use for the good of man."

MANITOBA'S MINERALS.

By Dr. R. C. Wallace.*

It cannot be said that a great deal of attention has been paid to the possibilities of Manitoba as a mineral producer. This is as might be expected in a province where agriculture has been and is of paramount importance. And yet the soil is not the only natural asset of any country; and a systematic investigation of the mineral resources must always play a prominent part in contributing to the development of the whole.

If we associate with the name of minerals such ores as are mined for gold or silver or copper, then it is indeed the case that minerals and good agricultural soil are not, as a rule, found together in nature. But under mineral resources must also be included materials such as clays, shales, sands and gravels, limestones, marls and coals, all of which are frequently found in districts which support a thriving agricultural population, and all of which call for development in the agricultural areas of our own province. One need only instance the case of our neighbor across the international boundary line, where a strong State Geological Survey and equally strong School of Mines, both integral parts of the University of North Dakota, are doing magnificent combined work in directing the development of the clays, cements, and coals of that state along the most rational and economical lines. A study of the features of industrial progress in a state pre-eminently agricultural, which are to be directly attributed to the researches and guidance of these organizations, would well repay the people of Manitoba.

But at a time when the province is on the eve of entering into a larger heritage, it is natural that attention should be directed rather to what we are likely to obtain than to what we already possess. Although certain areas in the vast Archaean territory of the new Manitoba have a coating of clay sufficient to provide an agricultural soil, the possibilities of revenue lie mainly in the mineral resources, the timber, the fisheries and the water power which the new territory will provide. And it is here that the onus of the work will fall. Up to the present time it has been found possible to carry out organized geological survey work only along some of the principal waterways, and private prospecting has been desultory in the extreme. In order to realize the extent of our possibilities, and the importance of systematic work in this field, it need only be pointed out that in a district—comparatively speaking at our own doors—a discovery of gold was made over two years ago which has led to the influx of a large number of prospectors into that particular area; and this in a belt which had not previously been geologically examined or even topographically mapped.

In the great Archaean Shield discoveries of ore deposits have been confined to the belts popularly known as Huronian, and consisting usually of Keewatin, Huronian, and even younger deposits, which may be generally characterized as dark or dark-green schists, conglomerates and slates, in contradistinction to the lighter color of the surrounding Laurentian granites and gneisses. Of these dark schists there lie within the enlarged boundaries of the province several areas, no one of which has as yet been subjected to detailed investigation. Future exploration may discover still more such areas, and it is certain that the boundaries of some of those already located, as for instance the "Huronian" band in the basin of the Hole River, will be considerably extended in the future mapping of the areas concerned. Two of these "Huronian" belts—one of them rather extensive in area—will be rendered directly accessible by the Hudson Bay line. A

* Professor of Geology and Mineralogy, University of Manitoba, Winnipeg.

third is connected by water route with Cumberland House and the Saskatchewan. Our knowledge of the existence of a fourth is primarily due to the fact that it lies along the well-used canoe route between Norway House and York Factory. Other areas lie near God's and Island Lakes; and the Black Island and Hole River belt extends eastwards beyond the limits of the province.

What these formations will produce is as yet largely a matter of conjecture. One district—that of Star Lake—near the eastern boundary of the province, and forming the western extension of the Lake of the Woods area, has now reached the producing stage, and gold mining in the province is happily an assured fact. Another, the Hole River and Rice Lake area, has been the scene of exceptional activity during the past year, and capital is now interested in developing this district, in which gold has been found over a wide area, and which, if present indications may be taken as a guide, will be producing gold within the next two years. Gold has been found in more than one of the other areas referred to, iron in several, specimens of copper ore are by no means uncommon, and discoveries such as have been made at Sudbury and Cobalt, names of worldwide importance, are by no means beyond the range of possibility. And in this connection it may be well to remember that although Cobalt is only a few miles distant from one of the earliest routes of travel in the country, its wealth lay hidden till some ten years ago; and it was due to a cutting for the Canadian Pacific Railway that the world's attention was first directed to Sudbury.

But the glamor of the Northland ought not to blind us to the necessity of utilizing the resources more easily available within the limits of the province. If Portland cement were manufactured from raw materials mined in Manitoba, a very considerable saving in freight rates might be effected. Limestones sufficiently pure for this purpose outcrop at various points on Lake Manitoba, and the necessary clay or shale is available conveniently near at hand. The calcareous Niobrara shales provide a suitable material for a natural cement, and future investigations in this direction may result in considerable increased activity. Valuable gypsum deposits are mined in the vicinity of Lake St. Martin, and in the country between Lake Manitoba and Lake Winnipeg other beds may yet be found. Borings have shown the existence of gypsum over wide areas at varying depths from the surface. A pure friable sandstone at the base of the sedimentary strata of the province will provide a good material for a future glass industry. A good phosphatic shale which is found in the western part of the province will come into requisition as a fertilizer when the soil begins to show signs of exhaustion. Our limestones are already a valuable asset, not only from the point of view of building-stone, but as lime and rubble producers. Extensive northern areas of limestone are awaiting development, and for the furtherance of the "Good Roads" movement not only the limestones, but also the available sand and gravel ridges will be utilized. Because of our great clay resources the brick and tile industry will occupy a very prominent position for many years to come; and the Geological Survey is at present investigating the possibility of utilizing the stiff till underlying the upper clays. With regard to fuel, the value of peat is being more and more emphasized in Canada and elsewhere; and Manitoba has her fair share of this commodity. Of lignites, Turtle Mountain contains on a rough estimate 160 million tons; and the formations in which lie the Lethbridge lignites extends into Western Manitoba, and deep borings may yet repay the expense they entail.

In reviewing the mining situation of Canada for 1911, the Canadian Mining Journal is compelled ot state that this province pays as yet practically no attention to exploiting her mineral resources. When, however, the greater Manitoba of the future acquires the control of her natural resources, the authorities will undoubtedly see their way to initiate a vigorous policy of development of the minerals we will then possess.

Statement of Production, 1910-11.—The following figures are given as summarizing the present situation, in so far as can be done with the latest available figures. They will also serve to contrast the present with possibilities for the future, when serious attention is given to developing our minerals.

Total production for 1911	$1,684,677
Total production for Saskatchewan	618,379
Total production for Alberta	6,404,110

Detailed Statement for 1910.

Gypsum	$195,000
Clay products and sandlime brick	735,232
Granite	3,345
Cement	21,995
Lime	100,808
Limestone	328,029

RAILWAY BUSINESS FOR NOVEMBER.

The high tide of business in the United States continues to be reflected in the railway statistics compiled by the Bureau of Railway Economics from the reports of the railways to the Interstate Commerce Commission.

The returns for last November show an increase over November of the previous year, but do not maintain the ratio of increase displayed by the month of October; while operating revenues increased $122 per mile of line for the month, operating expenses increased $74, and net revenue only $48.33. Taxes were greater than for the previous November, amounting to $46 per mile of line. Operating income averaged $12.13 per mile of line for each day in November, an amount greater by $1.63 than for November, 1911. This is the entire amount available to the railways for rentals, interest on bonds, appropriations, and dividends.

For the five months of the fiscal year the net operating revenue per mile of line of the eastern railways, compared with the corresponding months of the previous year, increased 6.3 per cent.; that of the western railways increased 15.8 per cent., while that of the railways of the south increased less than one-tenth of 1 per cent.

For the eleven months of the calendar year the net operating revenue per mile of line of the eastern railways, compared with the corresponding months of the previous year, increased 4.8 per cent.; that of the western railways increased 7.4 per cent., while that of the railways of the south shows a decrease of 4.5 per cent.

LE BULLETIN DE L'ECOLE POLYTECHNIQUE DE MONTREAL.

L'Ecole Polytechnique, of Montreal, has deided to publish a monthly bulletin, beginning with January, 1913. This bulletin is published and edited through the co-operation of a number of the professors of the School. The first issue, which has just come to hand, is a thirty-two page, 6 x 9 in. book, handsomely bound in brown board. The bulletin is intended to help in furthering the interests of the graduates of L'Ecole Polytechnique in the School, and to follow and encourage scientific and engineering movements. The editorial and business offices are located at 228 St. Denis Street, Montreal.

THE TOWN OF MAGOG, MUNICIPAL HYDRO-ELECTRIC DEVELOPMENT.

BY A. C. DOCHERTY.*

The town of Magog inaugurated in January, 1912, its new hydro-electric plant on the Magog River, which supplies energy for its waterworks, and electric lighting system, also to the cotton mills of the Dominion Textile Company. This plant replaces the town's old development which had to be abandoned owing to its delapidated condition, and to its serious waste of water due to antiquated design, and non-utilization of the whole head.

The Magog River drains Lake Memphremagog, which is a considerable sheet of water, having a length of 30 miles and an average width of one mile and being fed by numerous small streams and springs. It affords a remarkable natural storage basin for regulation of stream flow which would be advantageous to all the powers on the Magog River, and to the St. Francis River, of which the Magog is a tributary. The flow at present fluctuates considerably, though the dam of the Dominion Textile Company, which controls the outlet of the lake, helps equalization to some extent.

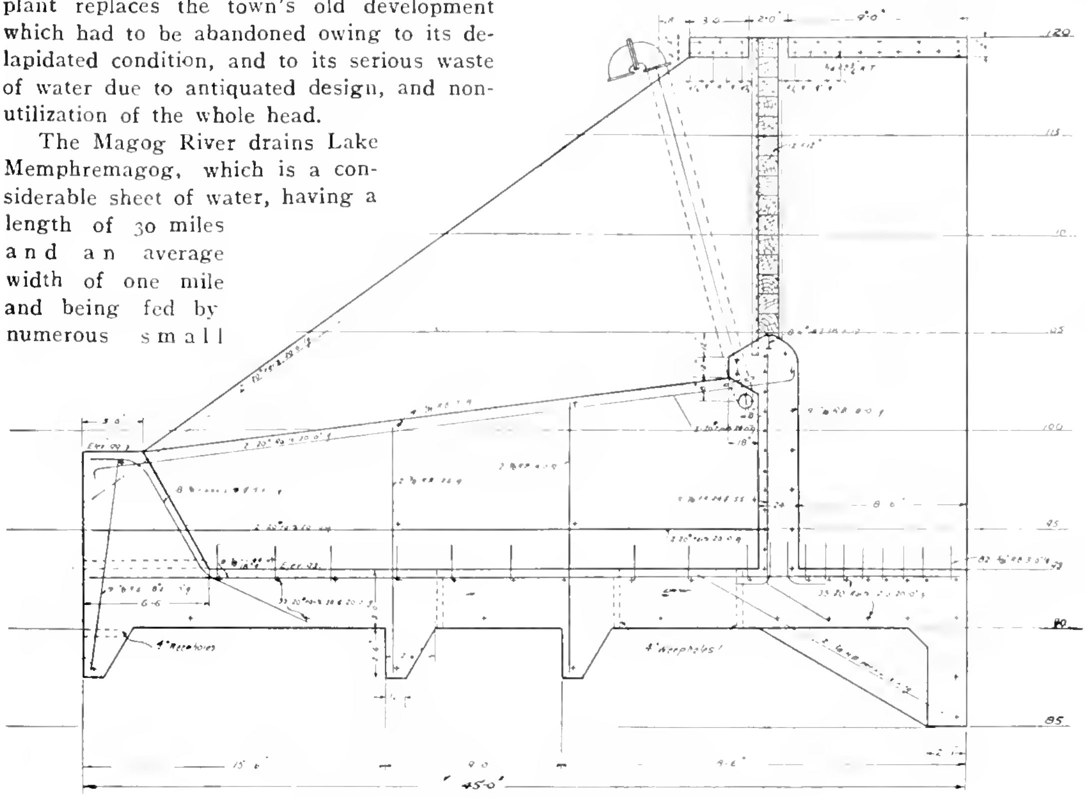


Fig. 1.—Cross-Section Through Sluiceways.

The Development.—The new plant is situated about two miles below the town, just below the site of the old plant, previously mentioned, and consists of a reinforced concrete power house, a reinforced concrete sluiceway, and earth embankment wing walls with concrete cores. Owing to the absence of rock, the design had to be suitable for an earth bottom, and erosion was guarded against by providing tumble-bays below the stoplog sluiceways in which the force of the falling water is absorbed by a water cushion, and by a timber crib which prevents any washing as the water leaves the tumble-bays.

The early spring of 1911 was spent in surveys and sinking test pits to obtain data for designing. The formation generally consisted of a top layer of gravel and boulders, and a heavy underlying stratum of hard clay. In March a wagon road was built into the site as well as a siding from the main line of the Canadian Pacific Railway. As the heavy blanket of snow disappeared clearing the timber and brush from the site, and flooded area was begun, and a start made on the first half of the cofferdam which was built around the site of the power house, work progressed rapidly so that by August 1st the river was turned through the turbine chambers and draft tubes, and the second part of the cofferdam, enclosing the sluiceway section, was begun. Simultaneously with the main part of the work, the concrete core walls and earth embankments were constructed, so that by October 30th the work was practically complete, except for its equipment, which was late in arriving, and it was not until January 20th, 1912, that current was turned on to the transmission line for the first time.

The Dams.—The concrete dam, 144 feet long, 35 feet high, 45 feet wide, at the base, is composed of six stoplog sluiceways and two blind sections, and is built with tumble-bays to break the force of the falling water, as shown in the section of the dam, Fig. 1. Four-inch weep holes are left in the floor of the dam for seepage and to prevent upward pres-

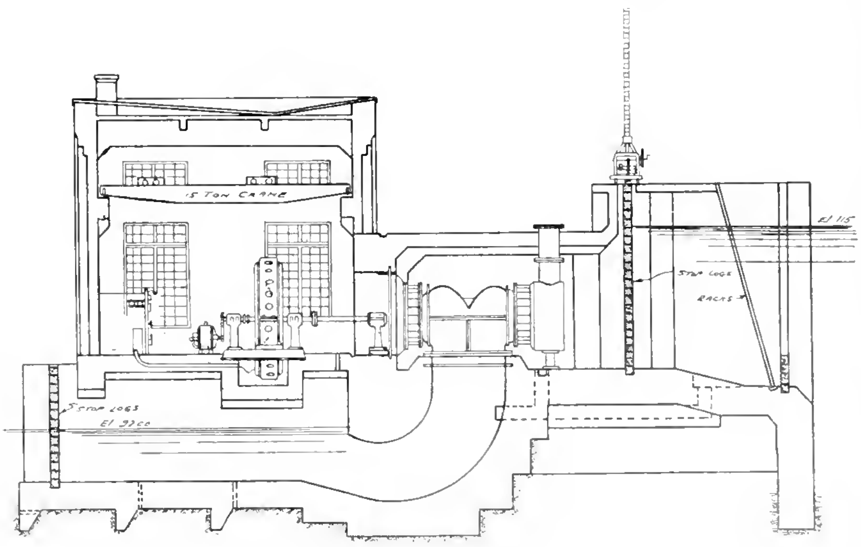


Fig 2.—Cross-Section Through Power House.

sure and a twelve-inch pipe is imbedded in each pier to prevent a vacuum behind the sheet of falling water. Two recesses, 12 inches by 14 inches, lined with a 12-inch channel are left in each pier to allow the timber stoplogs to slide in. The stoplog openings in the six bays are 15 feet high by 14

* Of T. Pringle & Son, Limited.

feet wide, and the stoplogs are removed and forced into place by a hand-operated travelling winch, which travels on rails built into the top of the dam. The winch operates all the stoplogs in both the dam and power house. A 12-inch reinforced concrete slab, nine feet wide, extends from pier to pier, to form a platform or runway.

The earth dam, which is 10 feet wide at the crest, is built with tapering concrete core wall extending into the hard pan; puddle is placed around the core, then sand and gravel, coarse gravel and boulders follow the puddle and rock fill around the toe. The slopes which are 2:1 are sodded to the water line.

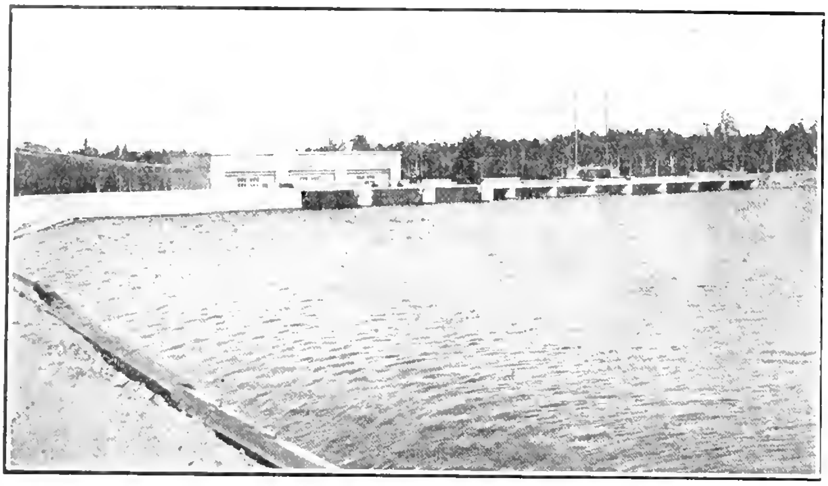


Fig. 3.

The Power House.—The entire power house, including the draft tubes, is built of reinforced concrete. Fig. 2 (cross-section) gives an idea of the construction, and Figs. 3 and 5 show the exterior. The structure is seventy feet long by twenty-nine feet wide and comprises three turbine chambers and generating room. Two sets of stoplogs are provided in the gate chamber to allow the racks to be repaired or cleaned out. The water leaves the turbines through an irregular-shaped draft tube, varying from a circle at the turbine to rectangular at the point where it discharges in the tail race. Cast iron manholes are built in the roof of the turbine chambers for inspection purposes. The power house is built for three units, two of which are at present installed—the third space being left for utilization when the flow regulation scheme for Lake Memphremagog is carried out. A fifteen-ton crane travels the lengths of the generating room. An excellent finish has been obtained on the concrete work, the general effect being good, and the large number of windows provides excellent lighting.

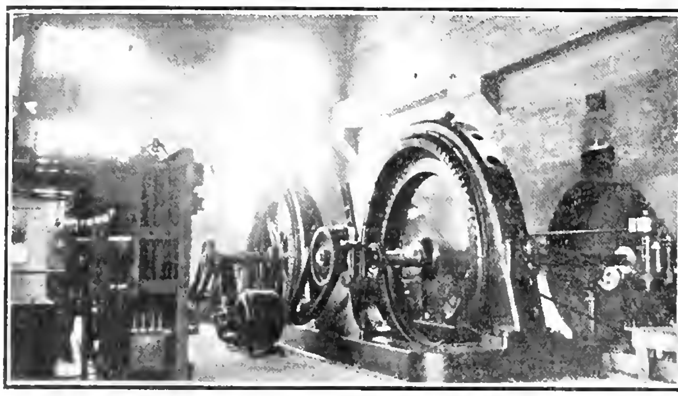


Fig. 4.

Fig. 5.

Hydraulic Equipment.—The present installation consists of two Escher Wyss water-wheels of the twin horizontal type, each of a rated capacity of 850 horse-power, at a speed of 150 r.p.m. under an effective head of 20 feet, with a guaranteed full load efficiency at full gate opening of 81 per cent. The turbine gates are of the wicket type, controlled by Escher Wyss governors. The regulation is 3 per cent. variation in speed on 25 per cent. change of loads and 15 per cent. on a hundred per cent. change on the basis of a fly-wheel effect of 225,000 lbs. feet.

Electrical Equipment.—This part of the installation has been designed to conform with the best modern practice. The generators are each of 500 kw. capacity and generate at 2,400 volts, 60 cycles, 2-phase, having a full load efficiency of 94.7 per cent. at 100 per cent. power factor and a regulation of 8 degrees from no load to full load, temperature rise of 35 degrees C. for 24 hours' run at full load. With a 25 per cent. overload the temperature rise will not exceed 50 degrees C. The outside diameter of the stator is 14 feet and the total weight of the generator is 50,000 lbs. The two exciters are shunt-wound each of 50 kw. capacity at 125 volts, 680 r.p.m., and are driven from the generator shaft by a silent chain, as shown in Fig. 4. Either exciter is capable of exciting both generators. The switchboard consists of six panels of marine finished marble, and is equipped with instruments and protective devices of the most modern type, to guarantee against breakdown and to ensure a constant and reliable service. There is one panel for each of the generators, one for the two exciters and two feeder panels. The generators are connected through double-throw oil switches to either of two sets of busbars. The exciters are also connected to duplicate busbars, so that the generator can take current from either exciter. The cables from the generators and exciters are run through the floor in fibre conduits to the switchboard. The outgoing cables are run along the wall in iron conduit and are protected by Garton Daniels lightning arresters.

Transmission Line.—The current is transmitted at 2,400 volts and the line is carried on 35-foot cedar poles, spaced 125 feet apart. There are three two-phase circuits of No. 0000 B. & S. bare aluminum wire, on three cross-arms, the wires being spaced 21 inches apart. Two of these circuits supply the cotton mills, the other going direct to the receiving station at Magog, a distance of about two miles.

Engineering.—The plant was designed and supervised by T. Pringle & Son, Limited, consulting engineers, of Montreal, Que., and Toronto, Ont. The power house and dam were built by the Bishop Construction Company, Limited.

The complete electrical equipment was supplied and erected by the Swedish General Electric Company, the transmission line by the Electric Repair and Supply Company, of Sherbrooke, Que., the hydraulic equipment by Escher Wyss and Company, of Zurich, Switzerland, and the stoplog winch by the Victoria Foundry Company, of Ottawa, Ont.

THE BRITISH COLUMBIA ELECTRIC RAILWAY.

One of the most active properties on the Pacific Coast is the British Columbia Electric Railway Company, Limited, of Vancouver, B.C., which has a number of important improvements under way, and which are noted in a recent issue of Electric Traction. Recently it arranged with the city of Vancouver for the construction of a new terminal for its Lulu Island interurban railway. This line extends from Vancouver through Point Grey to Eburne, from which point one division runs across Lulu Island to Steveston and another extends along the North Arm of the Fraser to New Westminster. Along this route settlement has been very rapid of recent years and a large commuter traffic is now carried on over the division. The line now enters Vancouver by a bridge spanning False Creek, terminating at a station at the water level. This location is inconvenient inasmuch as the station is located on low ground and passengers transferring to city lines must either walk up a steep hill or climb a spiral stairway to the level of the Granville Street bridge, over which run all the connecting city lines except one. The new arrangement proposed by the company is the location of an interurban terminal at the south end of the Granville Street bridge. By this plant interurban passenger cars will not be obliged to cross the False Creek bridge but will be brought into the city directly on a level with the Vancouver city cars. The terminal will also be of advantage to the city system as it is located near Fourth and Granville Streets, an important city transfer point.

The terminal will consist of two wings, each about 40 by 28 feet in size, connected by a covered passageway 25 feet in width, ample to accommodate the traffic from the interurban lines to the city system. In the south wing will be located the ticket office, agents' office, etc., while in the opposite wing will be a general waiting room and separate ladies' room. The terminal being located on made ground will be of wood construction. The plans call for a handsome structure costing between $30,000 and $40,000. The trackage arrangements provide a terminus for the Lulu Island cars on the west side of the station.

The management of the company is also providing for the comfort and convenience of the motormen and conductors employed on its Vancouver lines by the construction of a five-story club building at the corner of Main and Prior Streets, Vancouver. This location is directly opposite the principal car houses of the company in the city.

The building will have a frontage of 25 feet on Main Street a depth of 60 feet on Prior Street. The Prior Street frontage to the rear of the block is owned by the company and in the plans of the building arrangement is being made for the extension of the block should the need arise.

On the first floor will be located the general waiting room for the men and offices for the station master and inspectors. On the second floor will be a large billiard room which will be furnished with billiard and pool tables. On the third floor will be located the reading room and about one-half the floor space will be used for lockers. The fourth floor will be divided entirely for lockers, this accommodation in connection with the third floor providing lockers for over 500 men. The gymnasium will be located on the fifth floor, the entire flat being left free of obstruction as far as possible. In this room will be installed a complete set of gymnasium apparatus. The upper floor of the building will be reached by an elevator as well as a winding stairway. Lavatory accommodations are provided on each floor.

The block will be of brick construction, the frontage being trimmed with terra cotta. The estimated cost is between $30,000 and $40,000.

The management of the company recently announced that a contract had been closed with the Preston Car and Coach Company, of Preston, Ontario, for 65 city passenger cars. This is the initial order of the company for 1913 delivery. The cars are to be of single-end type and 44 feet in length. The specifications are still subject to minor changes but the cars will be of the latest model throughout. Delivery will be made during the months of April and May.

The company expects soon to operate its interurban line from Victoria north through the Saanich Peninsula, 22 miles in length. For this line orders for rolling stock have been placed as follows:—Two baggage and express cars from the Niles car and Manufacturing Company and six passenger cars from the St. Louis Car Company. For freight service 15 flats and 25 box cars have been ordered from the Seattle Car Company and two 45-ton locomotives will be taken from the mainland system for use on the new interurban line.

For service on its mainland freight lines, the company has recently ordered 25 box cars from the Seattle Car Company and five 50-ton locomotives from the Westinghouse Electric and Manufacturing Company, of Pittsburg. Other rolling stock recently ordered consists of two snow-sweepers from the Ottawa Car Company and six Hark-Otis steel dump cars.

During December full delivery was made of the 24 interurban cars ordered by the company from the St. Louis Car Company last summer and this equipment is now in service. The initial shipments have also been made by the J. G. Brill Company from its Philadelphia shops on the large order for city passenger cars recently placed with that concern.

In announcing its contract with the Preston Car Company, the management of the British Columbia Electric Railway stated that it was not the intention of the company to abandon the car building work in connection with its New Westminster shops. It was stated that the schedule for new rolling stock for all lines of the system for 1913 is now being prepared and in this program ample work would be allotted the New Westminster plant. At these shops is now assembled and finished a shipment of 25 steel city passenger cars which have been constantly arriving on an order placed some time ago in the old country.

LAKE SUPERIOR CORPORATION.

The Lake Superior Corporation propose to expend a large sum of money—$12,000,000 is mentioned—to extend its plant at Sault Ste. Marie, Ontario. Mr. J. F. Taylor, vice-president and managing director of the company has been in New York in consultation with his associates, and states that the company has determined to meet the Canadian demand for steel rails. Sixty-seven acres of land have been purchased for the proposed extensions. Another blast furnace and a new steel rail mill will be erected and large additions made to the open heart hand coke plants.

Mr. Taylor states that when the new works are completed the corporation will be in a position to turn out six hundred thousand tons of steel rails per year, or a daily average of two thousand tons, and he estimates that that will be sufficient to meet the requirements of the country. The maximum output of the present steel mill is about three hundred and sixty thousand tons a year.

STORM WATER DISCHARGE.

By R. O. Wynne-Roberts* and T. Brockmann.†

The subject of storm water discharge has been dealt with in two very instructive papers, one by Mr. Lloyd Davies, the city engineer of Alexandria, Egypt, and the other an expansion of the first, by Mr. Wallington Butt. Mr. Wynne-Roberts, however, in collaboration with Mr. T. Brockmann, has made a study of the matter, and purposes to present a series of articles, of which the following is the first, to explain the several factors that affect the solution of the above problem. As the theme is being developed, Mr. Wynne-Roberts proposes to show in what manner the calculations of storm water discharges can be made more comprehensively and accurately than, he is aware, has hitherto been suggested in the English language. He, however, does not claim any originality of the method to be described later on, as it is an adoption of an idea put forward by an eminent German engineer, the late Prof. Frühling, of Dresden. —[Editor.]

The engineer who is called upon to design sewers has first of all to decide whether it is advisable to adopt the "combined" system or the "separate" system. In the former the ordinary sewage and rainwater are conveyed by one common sewer, whereas in the latter case they are conveyed by separate conduits.

Whichever system is adopted, if the sewers are constructed practically water-tight, it will not be a difficult matter to calculate the probable volume of ordinary sewage, for it must largely depend on the consumption of water for various purposes. In Europe this quantity averages about 30 gallons per head per day, but in Canada and United States, for reasons which need not be gone into here, it ranges from about 40 to over 200 gallons per head daily.

The quantity of ordinary sewage will necessarily vary during different hours of the day and in different seasons of the year. The range of fluctuation in volume of sewage to be dealt with will approximately be from about 40 per cent. below to about 60 per cent. above the mean daily flow.

When, however, the engineer has to attack the problem of providing sewers to drain away storm water, he is confronted by many perplexing considerations. The quantity to be drained away per unit of time is generally vastly greater than the volume of sewage, so much so, that the latter can oft-times be ignored when calculating the dimensions of combined sewers.

While ordinary sewage has to be disposed of in volumes ranging within more or less definite limits, the quantity of storm water varies so enormously, it is so erratic in its periodicity, and is dependent upon so many variable factors, that it is not surprising some eminent authorities who have been extensively quoted, have abandoned all attempts to establish a general formula for this purpose.

This subject has engaged the attention of many capable engineers in Europe and America, some of whom have deduced formulæ by which they considered it was possible to arrive at the probable volume of storm water to be provided for, with sufficient accuracy.

The following are some of the formulæ which have been extensively quoted:—

Bürkli-Ziegler:

$$Q = R \times C \times \sqrt[4]{\frac{S}{A}}$$

McMath:

$$Q = R \times C \times \sqrt[5]{\frac{S}{A}}$$

$$Q = R \times C \times \sqrt[5]{S \times A^4}$$

Q = Cubic feet per second per acre reaching sewers.
Q = Cubic feet per second from the whole area drained.
R = Average rain during heaviest rainfall, in cubic feet per second per acre, varying from 1.75 to 2.75.
C = Constant, 0.75 for paved streets, 0.31 for rural districts, average 0.625.
A = Area of district drained in acres.
S = General fall of area per thousand.

Hawksley and Bazaloette:

$$\text{Log } D = \frac{3 \text{ Log } A + \text{Log } N + 6.8}{10}$$

D = Diameter of circular sewer in inches, to carry off a rainfall of one inch per hour.
A = Number of acres drained.
N = Length of sewer having a fall of one foot.

Kuichling:

$$Q = A \times a \times t \times (b - c \times t)$$

Q = Discharge in cubic feet per second.
A = Area drained in acres.
a, b, c = Empirical constants which vary for different localities.
t = Time required for the concentration of storm water at the outlet.

Lloyd-Davies:

$$Q = (60.5 \times \frac{60}{Tc} \times R) \times Ap$$

Q = Cubic fet per minute.
Tc = Time of concentration, i.e., time of flow through longest line of sewers in district in minutes.
R = Rainfall in inches during Tc.
Ap = Percentage of impermeable area in acres.

If the reader cares to solve any problem concerning storm water by the foregoing formulæ, he will find that the assumptions adopted by the different authorities are far from being uniform and the results obtained will be very dissimilar.

It is interesting as a matter of history, to note how Bürkli-Ziegler's formula was established. About the year 1878 he was city engineer of Zurich and during his term of office serious floods occurred, causing destruction, which was followed by litigation for compensation.

The information as to the intensity of rainfall and the quantity discharged into the sewers, was at that time very meagre and unreliable, and this induced him to take up the matter to see if some formula could be found to suit his requirements.

He found that Hawksley had assumed a rainfall of one inch per hour, which is equivalent to 70 litres per second per hectare, and had constructed a formula which, in metric terms, had the following expression:

$$D = 0.32 \sqrt[10]{\frac{A^3}{S}}$$

D = Diameter of pipe in metres.
A = Area in hectares.
S = Slope of area in 1,000.

* M. Inst. C.E., F. R. San. Inst., Consulting Engineer, Regina.

†Dipl. Ing. (Berlin), Civil Engineer, Regina.

Etylwein also had brought out his forumla for ascertaining the size of pipes, which was:

$$D = 1.2 \times \sqrt[10]{\frac{A^4 \times q^4}{S^3}}$$

q = Volume of discharge per second per hectare in cubic metres.

A and S were the same as above.

By combining the two formulæ, Bürkli-Ziegler obtained the value of "q" corresponding to the rainfall assumed by Hawksley. Thus:

$$D = 0.32 \times \sqrt[10]{\frac{A^3}{S}} \text{ equal } 1.2 \times \sqrt[10]{\frac{A^4 \times q^4}{S^3}}$$

$$q = 0.037 \times \sqrt[4]{\frac{S}{A}}$$

Reducing this to litres per second per hectare he got

$$q = 37 \times \sqrt[4]{\frac{S}{A}}$$

The ratio between the discharge and the quantity of rain fallen, which was sought for by Bürkli-Ziegler, was found thus:

$$\frac{\text{Volume of discharge}}{\text{Rainfall}} = \frac{Di}{Rn} = \frac{37}{70} \times \sqrt[4]{\frac{S}{A}}, \text{ say } 0.5 \times \sqrt[4]{\frac{S}{A}}$$

$$Di = 0.5\, Rn \times \sqrt[4]{\frac{S}{A}}$$

This is the classic formula deduced by Burkli-Ziegler. Considering 0.5 as the factor of impermeability denoted by "P" it then takes the form in which it has been so extensively published in America, etc.,

$$Di = P \times Rn \times \sqrt[4]{\frac{S}{A}}$$

Of the foregoing formulæ, the last (Lloyd-Davies) is the most advanced, but is does not satisfy all the conditions, as will be shown later on. With regard to the others, it can be stated that they are inadequate and no longer up-to-date.

These formulæ (excepting Lloyd-Davies') are unsatisfactory inasmuch as it is assumed that the discharge is constant, regardless of the shape and configuration of the drainage area, and the velocity of the flow in the sewers.

Lloyd-Davies' formula is an advance on the others, for it takes into consideration the above mentioned factors, which are ignored by the others, but which, nevertheless, are important, as they actually influence the discharge of the storm water. But he and Mr. Wallington Butt, who have read interesting papers on this subject, assumed that the entire area must be contributory to the flow in the sewers, before the maximum discharge is attained. This assumption, however, must be controverted, as it does not suit all conditions.

The principal factors which influence the discharge of storm water are:

1. Rainfall intensity.
2. Impermeability of the surface of the drainage area.
3. Retardation, which depends on the shape, extent, and configuration of the drainage area and also on the velocity of flow in the sewers.

1. Rainfall Intensity.—The annual rainfall in different parts of any country varies considerably. The mean annual precipitation over a long period, in parts of Prairie Provinces, for instance, is about 18 inches, but in other parts it is much less. In the semi-arid parts of the United States it is under 10 inches, whilst in the Canadian Rockies it must be many times as much. On Table Mountain, Capetown, the average yearly rainfall over a certain area is nearly 70 inches, but in the city, which is only four miles distant, it is 30 inches. In the Berg River Hoek watershed, which is about 50 miles inland from Capetown, the mean annual precipitation is about 120 inches, whilst in the valley, less than ten miles away, it is only 36 inches.

The mean rainfall in Germany is about 26½ inches, although near Berlin it is 24 inches and near Basel 33½ inches.

The rain, moreover, does not fall in convenient, uniform showers, but often in erratic torrential downpours, with very great intensity, during more or less short periods.

In New England, a rate of 3.6 inches an hour, continuing for 5 minutes may be expected every year or so, a rate of 2 inches continuing for 20 minutes; 1½ inches for 30 minutes, and 1 inch in one hour (Folwell).

(To be continued).

LOCATING A RAILWAY LINE.

By J. A. Macdonald.*

When surveys are to be conducted in a country which is timbered and little known, it is, in the long run, a great saving of time and money if it is practicable to have the engineer who is to have charge of the survey, accompanied by a good assistant, and say, half a dozen or more men, go over the country as best he can, running rough compass lines, using a micrometer, pacing or estimating for distances, taking barometrical altitudes, and generally becoming acquainted with the nature of the country and principal difficulties he may expect to have to overcome. Having gone over the whole of the section allotted to him, and thoroughly explored the country for several miles on either side of his rough compass line, he will have naturally formed some idea of the best route to be followed and save the cost of a large party running instrumental lines that may prove, after weeks of hard labor, utterly impracticable through running into some unforeseen obstacle. The engineer in charge of work of this character should be one who has had considerable experience in a timbered country, able to find his way anywhere, and not afraid of being lost. He should be able to establish his latitude and approximate longitude by observation though, owing to the difficulty in carrying a reliable chronometer, the latter is seldom to be relied upon. On reaching his point of departure his aneroid barometers, of which he should have at least two, or better four, having all been previously compared and rated, he will assume a datum for elevation for his work, and all altitudes should be reduced to that datum. By arranging the movements of his party he can provide that one barometer will always be stationary, and if a half-hourly record of its readings is carefully kept all altitudes taken by the party in the field can be reduced to one datum, the party having kept record of the time at which the observations were made. As is well known, such barometrical altitudes cannot be explicitly relied upon, but with care and good barometers it is surprising what close approximation to the true altitudes can be obtained. My experience has been that the aneroid barometers best suited for rough work are those about two and a half inches in diameter, divided to read five feet. The range of such barometers does not generally exceed two thousand eight hundred feet, but are much less

* Late of the staff of the National Transcontinental Railway.

liable to get out of order than the larger ones, which are supposed to read verniers to one foot.

Having thoroughly explored the country through which he is to operate, the engineer-in-charge selects a route for his preliminary line, and having been joined by his transitman and the rest of the party he proceeds with the running of such a line. If the country is rough and unbroken a transit should be used, but if tolerably level a picket line run by the aid of field glasses, the angles being turned with a transit or box sextant is generally the most rapid method and sufficiently accurate for preliminary purposes if the line is checked by compass bearings. The chainage should be done with a light steel chain.

Having assumed a datum for elevation, the levelling should in all cases be carefully done and checked wherever practicable, bench marks being established at least every half mile. Cross sections should be taken by the topographer as frequently as the nature of the country may require, to enable him to show contour lines for every five feet of elevation on either side of the line for considerable distances. As the through levels are not in any way affected by the cross-section work, these sections can be taken with sufficient accuracy with a good hand level, the distance right or left being measured with a chain or tape. It is a good practice to insist that the field notes of all instrument men be plotted up by the men who made them each night as the work progresses; this will save time and avoid many errors.

Having completed his preliminary line, the engineer-in-charge lays down on his plan, with the aid of contour lines, a proposed location and proceeds to stake it on the ground, the levels being checked with those of the preliminary line and bench marks established every thousand feet.

Having completed his first location and made any revisions that may have occurred to him, the engineer who has been in charge of such work should be moved on to other work and a new man put in charge of the party. This new man should, before taking charge of the party, be furnished with the plans and the profiles and given ample time to go out of the lines run by his predecessor. He may or may not be able to improve on the previous line, but in any case the judgment of two in place of one is obtained on final location.

In conclusion the commissariat for the survey party today is a very different matter from what it was thirty years ago. Formerly, if a party was well supplied with the necessaries of life, in the shape of bacon, beans, flour, tea, and sugar, it was all that they expected, whereas to-day, the addition of canned meats, dried fruits, vegetables and canned goods generally has added much to the variety of food supplied, but one thing that in the old days contributed more than others to the well-being and comfort of a party is still the same, namely, a good cook.

FACTOR OF SAFETY IN REINFORCED CONCRETE STRUCTURES.

In discussing the factor of safety in reinforced concrete structures, Mr. R. G. Clark, in the January issue of Ferro-Concrete, gives an interesting discussion. Mr. Clark says that the factor of safety in a reinforced concrete structure has generally been denoted by the ratio of the maximum working stress in the steel to the ultimate strength of the steel. For example, assuming that the working stress is 16,000 lb. per square inch, and the ultimate strength is 64,000 lb. per square inch, the factor of safety would be 4 by this theory.

Others, again, take the view that if the steel is stressed beyond the elastic limit the structure has, to all intents and purposes, failed, and, taking this line of reasoning, the factor of safety is expressed by the ratio of the maximum working stress to the elastic limit of the steel. Assuming the working stress at 16,000 lb. per square inch, and the elastic limit at 45,000 lb. per square inch, we then have the factor of safety reduced to about 2.75. This, however, is purely a theoretical calculation which deals with the steel only, but in any scientifically designed reinforced work we know that the concrete shares with the steel an equal responsibility concerning the stability of the structure, so that before the factor of safety can be accurately determined it is essential to see that the concrete also has an ample margin of safety.

The designer, in the matter of the quality of the steel, can safeguard himself by specifying that the British Standard Specification must be adhered to, but unfortunately no such standard is available for the concrete.

It is true that as far as the cement is concerned we have the assistance of the British Standard Specification as regards quality, but in the matter of the quantity of cement the greatest latitude is allowed when we have mixtures varying from 1:4 to 1:9 parts of cement to aggregate.

Dealing with the aggregate used for the concrete, this is more or less controlled by the materials available in any given district, and here again, to make matters worse, much difference of opinion exists as to suitable concrete materials. Very often the selection is left to the contractor, whose natural aim is to get something cheap in order to outstrip his competitors, and as the designer is generally many miles away he may not know of this arrangement, and the prejudicial effect it may have upon the factors of safety provided by his elaborate calculations.

In the past it cannot be denied that the concrete has been more or less overshadowed by the advocates of particular kinds of reinforcing steel, but the concrete in reality needs more attention than the steel, not only because of the reasons stated above, but also for the reason that the lifetime of the structure depends upon the efficient protection of the steel from corrosion. Therefore, as we assume in assessing the factor of safety of the steel that it will not deteriorate, then every care must be taken to protect it, and this can only be done by having the concrete composed of the best materials available, carefully graded and mixed with a generous quantity of the best cement.

It is by no means uncommon for competitors to state their calculated factor of safety, and it is interesting to note that for precisely the same work the factors of safety given by various firms vary from 4 to 9.

How the latter figure is arrived at is frequently a mystery, especially in cases where the firm submitting the lowest tender quote the highest safety factor.

It is obvious that something should be done to standardize the method of calculating the factor of safety, and that any method adopted should include due consideration of the strength of the concrete mixtures. It is altogether unfair to fix a limit of working stress on the concrete unless inquiry is also made into its constituent parts, as the limit may be much too low for some mixtures or too high for others.

In conclusion, it must be pointed out that the actual factor of safety is much above the calculated value if the best materials are used, but it should be remembered that the calculated factor of safety is only used for purposes of comparison. With a good concrete and steel efficiently protected the factor of safety increases as time progresses, owing to the fact that the concrete increases in strength with age, and in this respect affords a striking contrast with structural steel, timber or brickwork, which are at their best when new.

WATER RAM RESULTING FROM THE OPERATION OF A HYDRAULIC ELEVATOR.

About three years ago the Northeast Harbor Water Company experienced difficulty with fluctuations of water pressure arising from the operation of a hydraulic elevator. The company served notice upon the proprietor of the building in which the elevator was installed, to install a tank to supply water through a 4-in. service pipe for the operation of the elevator instead of drawing water for that purpose directly from the 8-in. street main. The proprietor objected to installing tanks. The company notified him that his water supply would be shut off unless he complied with their requirements. At that point the proprietor brought suit in equity to enjoin the company from shutting off his water. The result of the case, which was tried in April, 1910, may be summarized briefly as follows: The court decided that the use of water for a hydraulic elevator was a domestic use within the ordinary meaning of that term. On this ground it ruled that the company was obliged to furnish water for a hydraulic elevator, if the proprietor so desired. The court ruled, however, that the company was justified in asking the proprietor to install a tank of suitable capacity to relieve the street mains from the water ram caused by operating the elevator by direct pressure from the mains. The court decided, further, that the requirement of the company was justified since its order was given to protect its own property and to safeguard the interests of other water consumers on the same main pipe line. The injunction was not granted and the company was left free to enforce its ruling unless the proprietor substantially conformed to the requirements it laid down.

Mr. Charles W. Sherman, principal assistant engineer with Metcalf and Eddy, of Boston, was called as an expert witness by the proprietor. The results of tests made by Mr. Sherman in preparation for his testimony as well as the principal figures submitted by the water company, were given in Mr. Sherman's paper before the New England Water Works Association at the annual meeting of the association which was held in Boston on January 8, 1913. The information here given is taken from Mr. Sherman's paper.

The hotel was supplied by a 4-in. pipe, 300 or 400 ft. long, leading from an 8-in. main supply pipe at a distance of some two or three miles from the pond from which the supply is taken. The hydraulic elevator—the only one in town—is of an old type and has a total lift of about 32 feet. The travel of the plunger is about 4 feet, and its diameter is 22 inches. It was found that the elevator valve was made to open or close a series of holes, with the intention of making the opening or closing rather slow; and that it was necessary to overhaul 4½ ft. of valve rope to open or close the valve, or 9 ft. to reverse the elevator. The static pressure at the hotel was about 40 lbs. per sq. in., and a relief valve set at 45 lbs. had been installed near the elevator.

Nobody seemed to know just how long it took the elevator to make a trip, but it was conceded that it could hardly have been less than 30 seconds. Assuming this to be correct, the 22-in. plunger traveled about 4 ft., and consequently the displacement was 79 gals. in 30 seconds, or the flow was 158 gals. per minute. This flow corresponded to a velocity of less than 3 ft. per second in the 4-in. pipe, which is certainly not an excessive velocity. If this could have been checked instantaneously the resulting water ram would have been considerable, but it would obviously have required an appreciable time to overhaul 4½ ft. of valve rope to shut off the water.

The data available before the water company had presented its case were not sufficient to enable Mr. Sherman to make an estimation of the increased pressure which might have resulted from the operation of the elevator, to which he would care to testify. In order to get some information an experiment was made, through the courtesy of the superintendent of the waterworks at Ellsworth, Maine, where the court was in session. Here a place was found where there was a 4-in. pipe, some 400 ft. long, supplying a locomotive standpipe, where the normal pressure was about 68 lbs. per sq. in. This branch, like that at Northeast Harbor, was from an 8-in. main leading from the reservoir at a considerable distance. No method was discovered of drawing water, or of opening and closing the valve, at the same speed as with the elevator, so it was determined to make the test as severe as possible. The pressure gauge was attached to a house service pipe about 150 ft. from the locomotive standpipe, and the standpipe valve was opened wide, as rapidly as possible, left open until a condition of steady flow was obtained, and then closed as rapidly as possible. Mr. Sherman estimated the maximum velocity in the 4-in. pipe at not less than 10 ft. per second. The time of opening the 4-in. valve was 30 seconds, and the time of closing was 20 seconds. The pressure dropped almost immediately upon starting the valve from 68 to 28 lbs. per sq. in., or to 41 per cent. of the normal. At the instant of closing the pressure gauge registered 134 lbs. per sq. in., or 202 per cent. of the normal.

Mr. Sherman considers that this maximum pressure is not great enough to be dangerous to any well-constructed pipe system, although he believes that the sudden fluctuations would doubtless be annoying at times.

The officers of the water company presented gauge readings showing what the actual fluctuations had been in various parts of town. The significant figures, as taken down during the testimony, are as given in Table I.

Table I.—Pressures Observed at Various Places During Operation of Hydraulic Elevator.

Pounds per square inch			Per cent. of normal	
Normal.	Highest.	Lowest.	Highest.	Lowest.
56	75	40	135	71
58	60	35	104	60
55	62	32	112	58
32	40	10	126	31
32	50	10	156	31
60	80	40	133	67
58	85	35	147	60
55	75	35	136	63
54	70	25	128	46
51	70	28	137	55
30	50	10	167	33
30	50	8	167	27
28	60	10	213	35

The figures given in Table I. show that in general the operation of the elevator caused a drop in pressure ranging from 40 per cent. to between 60 per cent. and 70 per cent. when the valve was opened, and an increase in pressure, or water ram, amounting to from 30 to 50 per cent. of the normal pressure under ordinary circumstances, and sometimes running up to about 100 per cent. increase in pressure.

These results confirm in a general way the conclusions reached by Mr. Sherman from the experiment described above—that the pressure might drop about 60 per cent. below normal when the valve was opened, and rise to a maximum of about 100 per cent. above normal at the moment of closing the valve. These fluctuations are sufficient to cause annoyance, but where the normal pressures are as low as in the cases cited, should not be dangerous to the pipes.

Mr. Sherman points out that none of these results can be applied to conditions differing materially from those here described, but they may serve to give some indication of the extent of the water ram that may be experienced in a small waterworks system from the rapid closing of valves or fire hydrants.

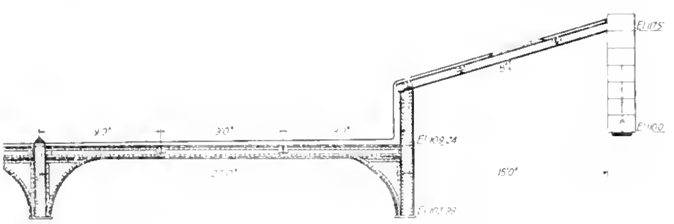
THE OTTAWA PASSENGER TERMINAL TRAIN SHED.

Three types of train shed are in general use, the long-span, high-arched roof type, the open platform canopy type and the short-span, continuous low-roof type.

The following comments and abstract from an article in a recent issue of the Engineering Record in which the Jersey-Central freight shed and the Ottawa train shed were described. The details which deal with the Ottawa shed are here abstracted.

The long-span, high-arch roof type, while having an imposing appearance, cannot be easily ventilated, and the gases not only are an annoyance to passengers but attack the steelwork, necessitating frequent painting, which is expensive because of the height of the structure. Even then the life of the shed rarely exceeds 20 years. The soot moreover impairs the lighting and the inaccessibility of the sky-lights makes their cleaning difficult. As a consequence of the frequent cleaning of skylights and painting the maintenance costs are high. The width of the shed is limited by the moderate length of span of arch roof trusses, and with increasing business, additions to the trackage are not possible without building a new shed or housing the new tracks beneath a structure having no architectural unity with the main shed. The first cost is also high, and increases much more rapidly than in simple proportion to the width of the structure. Its erection is expensive, requiring elaborate falsework.

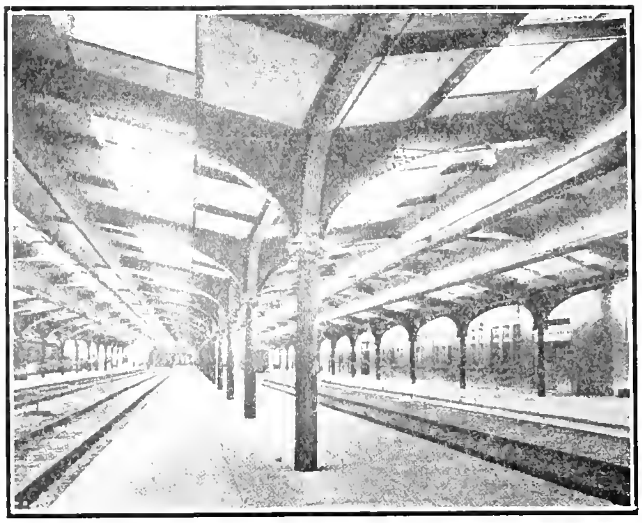
The canopy shed is simple and inexpensive, is adaptable to future longitudinal and transverse extension and is accessible for maintenance and repairs. It does not retain locomotive gases, and the ventilation is therefore good, and the



Part of Section Through Ottawa Train Shed and Head House.

corrosion a minimum. Besides it affords unobstructed light and lends itself to convenient and cheap methods of erection. It does not, however, offer a sufficient shelter from wind or driving rain or snow. The roofs extend beyond the platforms only a few feet, at most, and consequently the tops of the cars act as chutes to carry rain from driving storms on to the platforms.

The short-span, continuous low-roof type, represented by the Bush train shed, full details of which are given in this article in connection with a description of the shed now being built at Jersey City for the Central Railroad of New Jersey, has longitudinal rows of columns carrying short-span transverse roof girders that support a continuous roof surface sheltering the whole area of the shed. By means of a concrete duct over each track, gases, smoke and cinders are carried outside at once, and in consequence there is neither annoyance to passengers nor deleterious action on the steelwork. The ducts are so deep that wind, rain and snow cannot drive into the shed. The skylights are readily accessible, thus insuring frequent cleaning, with consequent good illumination in the shed. It should be noted that deposits of soot on the under side are entirely avoided, since the smoke does not enter the shed. Painting is likewise facilitated, and



Interier View of Ottawa Train Shed.

since, in addition, no more painting is required than for ordinary steelwork, this item of train-shed maintenance cost is reduced far below that for a high-arch shed. The freedom from gases gives these sheds practically unlimited life, provided they receive ordinary maintenance and care.

In first cost the shed is more economical both in material and in erection. The steel required per square foot of shed is not more than half that needed for a high-arch shed. Instead of using costly falsework, as is required for the high sheds, the erection is accomplished by an ordinary derrick car, and by taking one bay at a time the work can proceed without interrupting traffic. Should increased trackage be needed there is no difficulty in adding more bays of the same design, thus preserving the architectural unity.

The Ottawa train shed is of the Bush type and has recently been completed for the Grand Trunk Railway Terminal at Ottawa, Canada, Mr. H. R. Safford, chief engineer, and Mr. Wm. McNab, principal assistant engineer. It is 533½ feet long and 163½ feet wide and has seven tracks. The principal structural differences are in the use of a concrete longitudinal sidewall along one side of the shed, provided with movable windows for side ventilation and the substitution of riveted girders for I-beam longitudinal girders connecting the tops of the columns. The passenger platforms between the tracks consist of solid concrete slabs laid on the surface of the ground, and the columns are supported on piers without pile foundations.

A NEW MONTHLY MAGAZINE.

The first issue of "Steam Machinery," published by the Steam Machinery Publishing Co., of Duluth, Minn., has just come to hand. The magazine is devoted to descriptions of machinery and methods, and this first issue presents a most pleasing typographical appearance. In the editorial announcement the following statement of its purpose is given: "We believe the times are ripe for a frivolous magazine with a serious purpose. We believe this to be the sub-conscious spirit of these times. To laugh a lot; to work a lot, and to live like Billybedarned!"

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc. MANAGING EDITOR — A. E. JENNINGS, ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc. CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each. Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, FEBRUARY 13, 1913. No. 7.

CONTENTS OF THIS ISSUE.

AN EXAMPLE OF COUNTY COUNCIL CONTROL.

A good example of the manner in which engineering and construction work is handled by municipal bodies is shown in the management of the good roads system in the county of Welland. At the last meeting of the County Council a by-law was passed appointing Mr. George Ross, of Welland, as engineer in charge of the work in place of Mr. J. C. Gardner, of Niagara Falls.

A year ago Mr. Gardner was appointed as engineer for the county good roads system, and three foremen, who were conspicuous more for their political activity than for their ability as construction men, were placed on the work. The work of organization and the buying of new machinery and supplies took up a good deal of time, and a great deal of time was wasted, in addition, by the council in quibblings and dickerings over what should be done. Instead of the work being placed under a small executive committee of the County Council, the whole Council acted as a committee on the work, with the result that much valuable time was lost.

Instead of this year giving Mr. Gardner full control of the situation by allowing him to appoint his own foreman and men, and profiting by the experience of last year, the Council have removed Mr. Gardner to make way for another man. Such injustice and lack of business capacity is typical of bodies of men, made up as county council is. Where political pull and local jealousies and prejudices are allowed to interfere with the carrying on of public work, inefficiency and waste is always the result.

CLASSIFICATION OF COAL LANDS.

It is a widespread popular impression that if coal is found outcropping on a tract, the land is coal land, and that if no coal is to be found outcropping the land is non-coal land. If this were true, probably more than one-half of the coal produced in the country (in some States more than 95 per cent.) would be coming from mines not on coal land.

As an illustration, 196 mines in Indiana in 1908 produced 11,997,304 tons of coal. Of these 196 mines, fifteen were working the coal from the outcrop, and produced 400,733 tons, or a little over 3 per cent. of the total. The rest was mined from land, the surface of which showed no coal. In Illinois the percentage is still less, and in both States the average production of the mines working on the outcrop is small, compared with the average of all the mines. The percentage of coal worked from the outcrop is greater in Pennsylvania, West Virginia, and the southern Appalachian States than in the two just cited, but not much, if any, greater in the Michigan field, the western interior field, or some others of the large fields of the country. It is true that in many of the fields when first exploited mines were mostly driven in on the outcrop, but for two reasons that condition has greatly changed: First, the coal close to the outcrop has been mined out; and second, after a time it has been found to be cheaper to mine the coal from shafts sunk to the bed from a point some distance back from the outcrop than to haul the coal, water, and waste up the slope of the bed as it pitches into the ground.

If, therefore, any producing coal field is examined there will usually be found a belt of outcrop in which the coal-bearing rocks rise to the surface of the ground, and outside of that belt an area, which may amount to thousands of square miles, where the coals are all below the surface, and the surface rocks may even be of en-

tirely different age, and perhaps not coal-bearing at all.

If in any tract a bed of coal of workable thickness outcrops it evidently does not underlie all, and may underlie only a small part of the tract, and to that extent the land is not coal land, so that it sometimes happens that a bed of coal outcrops or is exposed on a given tract, and yet underlies so small a part of the tract that it would hardly be fair to consider the whole tract as coal land.

In Indiana shafts have been sunk to coal beds at a depth of 250 feet without any preliminary drilling where the coal bed did not outcrop nearer than fifteen miles, and many of the mines of Illinois are twenty-five to fifty miles from the nearest outcrop of the coal they are working.

In classifying land as to its coal character a few general principles are involved:—

1. If the land is known to be underlain only by groups of rocks known nowhere to contain coal, the land is assumed not to be underlain by coal and to be non-coal land.

2. If land is known to be underlain by one or more groups of rocks known to contain workable beds of coal, and a study of the dips shows that those groups are not too deep for the coals they contain to be worked, the land may be presumed to be coal land.

In nearly all cases where public lands have been withdrawn pending examination and classification it is known or believed that the land is underlain by groups of rocks known elsewhere to contain workable beds of coal. In probably a majority of cases it is also known, or later examination demonstrates, that coal does not outcrop on most of the land withdrawn, but underlies it, perhaps at a considerable depth.

Given, then, an area of public land withdrawn for examination and classification, under what conditions will it be classified as non-coal land?

1. Detailed examination may show that the coal-bearing group of rocks may have thinned out before reaching the area, so that although the rocks above and below this particular group are found to underlie the area, and normally this particular group should also, yet under the circumstances, if this is the only coal-bearing group in the region that might underlie the area, it is classified as non-coal land.

2. Detailed study of the dip and lay of the rocks may show that the coal-bearing group lies deeper than the limiting depth imposed by the departmental regulations governing the classification of coal land, and the area must, therefore, be classified as non-coal land.

3. Detailed study may show that the area is underlain by a coal-bearing group of rocks within minable depth, but the coal is too low in grade to be worked, or it may be found that the coal occurs only in local pockets, none of which are thought to extend under the area involved.

Where, as is the case in many parts of the western coal fields, more than one group of coal-bearing rocks exists in any area, it must be found that the facts above stated are true of each group before the area can be classified as non-coal land.

On the other hand, if, although there is no coal outcropping within many miles of a given tract of land, it appears to be true that the tract is underlain within workable depth by a group of rocks known to contain coal beds of such character, thickness, and extent as to make it highly probable that they underlie the tract within workable depth and are there of workable thickness and quality, the tract is classified as coal land.

When such a tract of coal land is valued the attempt is made to take into consideration all the data bearing on the problem, possibly data covering half the State, or more, including usually data on every coal bed in every coal-bearing group of rocks of that field, to ascertain as nearly as possible how many groups of coal-bearing rocks underlie the tract, how many beds are of workable thickness, the thickness, chemical and physical character, depth, pitch, and any other factors affecting the workability and value of the coals, and then to make all due allowance for depth, uncertainty, distance from outcrop, etc., according to fixed schedules and regulations.

It must be admitted that the data gathered for many tracts are very meagre, and a large element of uncertainty enters into the final result, but it is believed that in the vast majority of cases the allowance for uncertainty is so large that additional data, even though they show less coal than might have been expected, will, by diminishing the factor of uncertainty, tend to raise the price rather than reduce it, for, as a rule, where the uncertainty is large only the minimum price is put on the land, and unless evidence such as that obtained by deep drilling or new prospecting shall demonstrate beyond question that the supposed beds of coal are absent or too thin or too poor to work, the classification will not be changed.

The evidence obtained by the United States Geological Survey consists of observed outcrops and measured sections, properly located and described on the spot, and analyses made in the Government laboratories from coal samples collected in a definite, prescribed way, supplemented when necessary by such second-hand data as appear to be accurate and reliable, and to be in accord with the personal observations of the field men.

EDITORIAL COMMENT.

At the annual dinner of the Dominion Marine Association, held last week in Ottawa, the Minister of Railways made an announcement concerning the new Welland Canal which shows that the Government and Mr. J. L. Weller, the engineer-in-charge of the design of the new work, are thoroughly alive to the necessity of providing for the future of the shipping interests of the Great Lakes. He stated that the lock-gates on the new Canal would be thirty feet in depth, although the depth of the Canal itself would be only twenty-four and a half feet for the present. When the locks at the Sault on both sides of the river are deepened to thirty feet, as they eventually will, it will be a simple matter to provide this depth on the Welland Canal by dredging.

SAULT STE. MARIE DRYDOCK.

Substantial interests are backing the enterprise of the Sault Ste. Marie Drydock and Shipbuilding Company, Limited, particulars of which appeared in The Monetary Times last week. The shareholders in the company consist of the estate of the late Mr. W. H. Plummer, Messrs. J. O'Brien, J. J. McFadden, J. O'Boyle and D. P. O'Boyle, all of whom are well known throughout Ontario; Sir Alexandre LaCoste, Messrs. Ernest Marceau and F. H. Clergue, of Montreal; A. Simpson, of Ottawa, and other Canadian interests. Among other strong financial European interests are Mr. Robert E. Pauwells, of Brussels, Belgium; Mr. William Brice, of London, England; Dr. Charles Casoretty, of Paris, France; and Messrs Pethick Brothers, Limited, of Plymouth and London, England.

RAILWAY HEADLIGHTS.

A review of the requirements for locomotive headlights by G. H. Stickney, is given in the January issue of the Lighting Journal, from which the following is taken:

In connection with the recent developments in drawn wire filament tungsten lamps, the writer has been led to look up the locomotive headlights as a possible application. It is the general practice to utilize for this purpose flame oil lamps equipped with parabolic reflectors so as to concentrate the light into a beam, although within the past few years, electric arcs have been substituted for the oil flames in some sections of the country.

In considering the application of tungsten filament lamps, the first question which arises is what intensity of beam is desired. Investigation shows that there is a wide variation of opinion among railroad men in regard to this point. Some insist that the headlight should be very powerful so as to illuminate a long distance ahead of the locomotive, while others object seriously to a powerful beam and demand that the headlight be made simply a marker. Analysis seems to show that the demand for the powerful headlight runs strongest on railroads which have a considerable amount of single track, while the other extreme reflects the opinion of such railroads as have two to four tracks and extensive block signal systems. And this appears to be logical. On the single track road the most dreaded accident is the head-on collision, and the powerful headlight is unquestionably an important means of last resort in preventing such accidents. On the double track roads the danger of head-on collisions is minimized, while complaint is frequently made that the headlight of an approaching locomotive momentarily blinds the engineer and may prevent his seeing properly. The further objection has been raised of the interference due to the reflection of light from signal glasses or rondels.

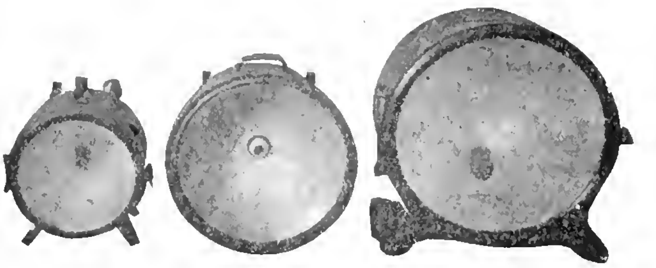


Fig. 1.—Types of Railway Headlights.

A thorough test was carried on by Profs. Harding and Topping, of Purdue University, in 1910, and their report, which may be found in the Transactions of the American Institute of Electrical Engineers, indicated in favor of a headlight of intermediate power; that is, one which would avoid the glaring and reflection effects of the powerful arc headlights and yet furnish a much stronger beam than the ordinary low intensity oil headlights.

There is, however, another phase of this question: namely, the legislative requirement. In many of the states laws have been passed regulating the headlights to be used on locomotives. Inquiry was made into the requirements of various states, and the following collation, prepared by Mr. L. C. Porter, gives a general idea of the requirements.

The States of New Jersey, New York, Connecticut, Minnesota, New Mexico, North Dakota, Virginia, Wyoming, Iowa, Massachusetts, Pennsylvania, Rhode Island, Vermont, Nevada, New Hampshire, Michigan, West Virginia, Nebraska, Missouri, and Delaware advise that they have no law covering this subject.

Colorado and Kentucky have had a bill requiring [illegible] of "1,500 unreflected candlepower" headlights introduced, but the bill was defeated.

Illinois had a bill introduced and defeated requiring each locomotive to carry a headlight of sufficient candlepower to enable the engineer to distinguish a human form at a distance of 800 feet.

Arizona has a bill pending requiring the use of a high candlepower headlight this bill calling for "1,500 unreflected candlepower" on all locomotives except switch engines.

North Carolina requires a locomotive headlight of "1,500 unreflected candlepower" on all locomotives, with the exception of switch engines, on roads having 100 miles or more of track within the State.

Washington requires that each locomotive be equipped with an electric headlight of approved design and capacity.

Montana requires that each locomotive, with the exception of switch engines, be equipped with electric or other headlight of 1,500 candlepower when measured without a reflector.

Wisconsin requires that each locomotive be equipped with a headlight which will enable the engineer to see a man on a clear night at a distance of 800 feet.

Ohio requires that each locomotive, except switch engines, shall carry a headlight of such candlepower as to render plainly visible, at a distance of not less than 350 feet, whistling posts, land marks and other warning signs.

It is somewhat of a reflection upon the activity of illuminating engineers that in no case was the intensity of beam specified in beam candlepower or foot candles at some specified distance. It does not seem reasonable or good practice to require 1,500 unreflected candlepower, without any mention of the quality or condition of the reflector. While it might be presumed that an efficient parabolic reflector would be used, there seems to be no assurance that this would be done. The specification seems to favor one type of unit to the exclusion of others which may be more effective, as well as more economical and practical.

The requirement of sufficient intensity to pick up a man at 800 feet is the most logical and sensible of any of the specifications given. While this is somewhat indefinite and somewhat difficult of exact determination, it was probably the best requirement that could be drawn up with the information then available. As suggested, this specification could readily, by a series of tests, be interpreted in terms of foot candles at, say 200 or 400 feet, or beam candlepower measured at corresponding distances. These values are more readily reproducible than general specifications, which may depend upon local conditions, such as the color of the roadbed, color of background, color of clothes worn by the man, etc.

It is understood that this question is now under investigation by the Wisconsin Railroad Commission and others, and it is hoped that good results will soon be available.

The writer has not made any accurate measurements to determine the relation between intensity and seeing power. A western railroad, which has been conducting such experiments, reports that, with an equipment utilizing a 100 c.p. tungsten filament lamp* with the filament concentrated in a cylindrical space about ½ inch long and ⅜ inch diameter, they were able to pick up a man on the track at 1,000 feet, the locomotive being stationary, and at 800 feet with the locomotive running 30 miles per hour.

Measurements with a similar equipment gave a beam candlepower of 50,000, which is equivalent to .078 foot candles

*The lamp mentioned was made up especially for the experiment and is not standard or commercially available.

at 800 feet and .05 foot candles at 1,000 feet. The beam candlepower obtained in this case indicates the inadequacy of the specification calling for 1,500 unreflected candlepower, which does not ensure anywhere near as powerful a beam as is here produced from a lamp giving only about 100 unreflected candlepower.

A second question which arises and to which there has not, as yet, been a final answer, is the requirement of the shape and width of beam. Ordinarily a fairly narrow beam would seem to be desirable, since it not only makes it practicable to furnish a high intensity down the track, but also minimizes interference with signals or approaching trains on either side of the track. On the other hand, a wider beam would be more useful on curves.

Still a third question is that of the color of the light. Professor Harding's report intimated, to some extent that interference with colored signals was in some degree due to the color of the light, but it is in its relation to weather conditions that the color of the light would seem to be the most important consideration. The headlight question would be a comparatively simple one if fair weather only were to be considered, but the real test comes on the foggy or stormy night, when the mist or rain not only breaks up the beam, but reflects the light back into the eyes of the engineer, thus causing a haze which makes it more difficult to see distant objects, which, in themselves may be darkened and rendered less visible by being wet. That the most powerful light may be the worst under such conditions is quite conceivable; on the other hand, we know that a red or yellow light penetrates a fog more readily than the other colors, and hence not only delivers a larger proportion of the light where needed, but also decreases the likelihood of the haze or diffraction effect obstructing the vision of the engineer.

It may be well to consider briefly the theoretical and practical requirements of a headlight for railway purposes, at least from a qualitative standpoint, assuming that a reasonably powerful headlight is desirable.

As is well known, a perfect parabolic reflector, equipped with an absolute point source of light at its focal point, would reflect all the light incident upon its surface in a direction parallel to the axis, and hence form a beam which would retain its intensity for an indefinite distance, barring only atmospheric absorption. In the practical application of this principle, it is not possible to produce a true point source, so that the actual light incident upon each point of the reflector will, in all cases, come from several directions, at least within an appreciable angle, and, since the angles of reflection and incidence must be equal, it is evident that each point of the reflector will emit a cone of light, depending for its width upon the angle which the light source subtends with reference to that point of the reflector. It is also evident that, since at a distance from the reflector these cones will appear to blend, the beam of light from a parabolic reflector must be in the form of a cone and be dependent for its spread upon the relative area of the light source. It therefore appears that, where a powerful, narrow beam is desired, it is essential that the light source be made as small and brilliant as possible.

This condition is, of course, best met with the D.C. open carbon arc, which can be so arranged that a large percentage of the light from the positive crater is projected upon the reflecting surface. The carbon arc, however, is efficient and stable only in high power units. With the recent development of the drawn wire tungsten filament, it has become possible to make lamps in which the filament is concentrated into a very small space, and is strong enough to withstand reasonably hard treatment. The lamp possesses the further advantage of being free from mechanism to get out of adjustment or requiring maintenance care, does not smoke or destroy the reflecting surface, and produces a light of slightly yellowish tint, which is favorable for inclement weather conditions.

Incandescent headlights have proved very satisfactory for automobiles and are being used to some extent on interurban electric cars. It would seem that this application to railway service is principally a question of determining the requirements and adapting the automobile type of equipment to them.

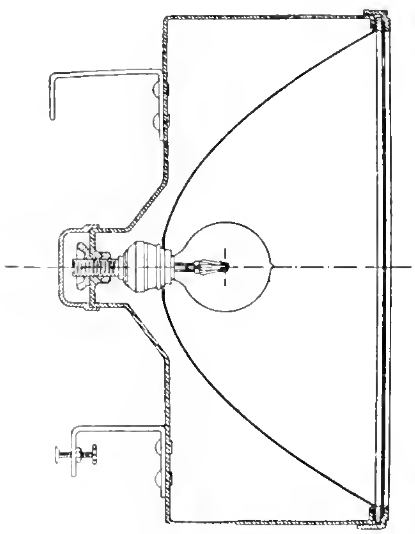


Fig. 2. Suggested Arrangement for Railway Headlight for Use With Mazda Lamp.

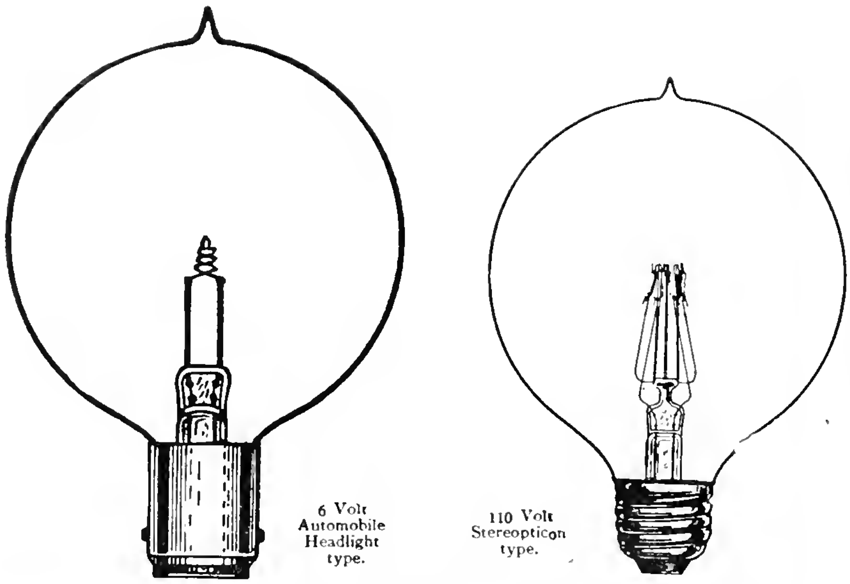


Fig. 3. Concentrated Tungsten Filament Lamps Suitable for Headlight.

Mr. F. H. Ward has resigned the position of vice-president of the Canadian Consolidated Rubber Company, but will remain a member of the executive committee and a director of the company. He will in future be associated with Mr. D. Lorne McGibbon

THE PIECEWORK OR UNIT SYSTEM OF HANDLING TIES AND TIMBERS.*

By W. W. Eldridge.†

The handling of ties and timbers on a "Piecework" or or "Unit" basis is, I believe, not universally practiced in the timber-treating industry. Some plants follow the practice to a greater or lesser extent under one system or another.

Our company has been using the piecework system of handling ties and timbers at both our plants for several years with what we consider the best of results, and my remarks will be confined to the efficient operation of a timber-preserving plant from a physical standpoint only.

A short time ago I asked my friend, Mr. Waterman, what he thought of the "piecework system," and he replied: "Piecework is the only thing for the timber-treating plant." This opinion is backed by thirty-odd years of practical experience in the handling of material, principally ties, piling and lumber, and men of all kinds, under both the "day work" and "piecework" system. I may be easier to satisfy or convince than some of you, but this recommendation is good enough for me. The proof of the pudding is in the eating, therefore, my only recommendation is that you taste it. If you like it you will eat more, if not you will leave it alone.

The question arises, "What is the object of piecework, and what are the advantages to be derived therefrom?"

The object of piecework is to get one dollar's worth of labor for one dollar, and to give one dollar for one dollar's worth of labor, or, in other words, to increase the efficiency in handling ties and timbers to the maximum so as to get the largest possible output at the least cost.

The advantages of the piecework system are numerous. In the first place, it reduces by approximately one-third the number of men required to do the work, and hence makes a corresponding decrease in the amount of supervision needed.

It enables you to get the "cream" of the laborers to do your work. There is no place for the "drone" in the piecework system, as he will be pushed aside and eventually crowded out.

It systematizes the work and assists materially in the accounting, figuring costs, etc.

It places each individual workman in business for himself, and enables him to secure pay for what he does. Being paid for what he does, it is natural for him to combine mental ability with physical strength in order to accomplish all possible.

Knowing that he is getting paid for what he does, and that in proportion as his efforts are increased his earnings are increased, he is able to make better wages than his fellow-workmen in other lines of business on a day rate system, hence he is satisfied and contented with his job at all times, and when the "shortage of labor" problem arises you will find your men still at the helm, while other industries on a day rate basis are suffering for lack of laborers, which means loss of business and decrease of efficiency and earning power. This condition brings out another important point, and that is, always treat your men in such a way and improve conditions to such an extent that the glitter of gold, so to speak, will not entice them to abandon the best of working conditions and a sure thing for an experiment. You will always find a few who are prone to become dissatisfied and wander away in search of something better, but my experience has been that within a short time they will drift back, sadder but wiser for their experience. Last, but not least, it promotes efficiency.

The installation of the "piecework system" is no small task. A great deal of tact and good judgment must be exercised, and unless it is established on good business principles it will be a failure rather than a success. There are a good many things to be taken into consideration along this line.

First, be open and above board with your men in everything you do in connection with their work, as it is of the utmost importance that the men fully understand what you expect of them, and what they can expect of you in return. You must have confidence in your men and they in you to obtain the best results to all concerned. Every detail should be fully explained to them. The existence of doubt would be disastrous, and might be likened unto the little Toredo, which enters the piling unseen and slowly but persistently destroys life and tissue until nothing but the shell is left and the piling fails. Metaphorically speaking, you should so thoroughly impregnate the minds of your men with the antiseptic "piecework" that there would be no chance for the little Toredo to gain entrance, to say nothing of existing, in your piling "the piecework system."

Second. Treat your laborers as men, and be fair and square with them at all times. Be ready and willing to counsel with them and explain any points that are not quite clear to them. My experience has been that there is a common feeling among men that in order to exist under the piecework system they must exert themselves unduly. This impression is erroneous, and you should disabuse their minds of the same. The man who starts out in the morning on a run to perform his work, regardless of method, does not accomplish the desired result, for the reason that he has set a pace that is not in keping with his physical ability, and before the day is half done he is exhausted and compelled to quit. What is the result? The man is dissatisfied because he is disappointed with the results of his efforts, and he immediately condemns the system when in fact he should condemn his own lack of good judgment. In no case should a man be permitted to set such a pace, but rather strike a good even gait that he can maintain throughout the day, and by combining method and system he will be more than satisfied with the result.

When you have done all this you have gained their confidence, and when you have won their confidence you have won a battle, gentlemen, that means much to you and to your men. The spirit of indifference vanishes, and the spirit of co-operation and mutual interest is enthroned in its stead. I doubt if any of us could place a monetary value on the loss incurred by the indifference, carelessness and wastefulness which is bound to occur when all men are classed as physically and mentally equal and all paid the same stipulated scale of wages for the same class of labor. If you are a careful observer and have ever taken the time to watch a gang of men working on a day-rate basis, they having no knowledge of your presence, what did you observe? This is what you saw. A gang of men organized to do a certain piece of work without regard to the number of men, their comparative size, strength or ambition. You saw one or two, or possibly three of the men performing, at least a part of the time, all of the work that was being done, while the rest of the gang was looking on. You also saw that their efforts were absolutely devoid of system. You will naturally ask, "where is the foreman?" in most cases he is everywhere but where he should be, but in either case you will invariably find that the foreman has imbibed the same spirit exhibited by the men under him, and the only purpose he serves is to point out to the men what he wants and leaves them to work out their own salvation in any way they see fit, regardless of time, ex-

* Abstract of paper delivered before the American Wood Preservers' Association.

† General Piecework Inspector (State Department), Chicago, Burlington & Quincy Railroad.

pense or efficiency. Only the other day I was going along the street when I saw a gang of twelve men handling some stone cornice work. For ten minutes eleven of these men did nothing, while the other one was trying to saw a one-inch board in two with a hammer. The board was finally cut, and then six of them picked up a piece of stone and loaded it on the wagon, and still there were six men looking on and drawing wages for expert advice or statuary effect, I presume. I could see no other reason for keeping them there.

What do we get out of this object lesson?

Woeful lack of efficiency and improper organization.

The foreman should have been released for permitting such a condition to exist under his supervision.

We find twelve men drawing wages for a six-man job. Undoubtedly the prevailing spirit was to let the fellow who was willing do the work.

With the piecework system it is different. Every man or gang of men secure a job on their merits, the goal is pointed out to them, and immediately they enter the race with a determination to reach that goal. Some few fall by the wayside, either for lack of strength, ambition or ability, but the majority of them win the race under proper supervision, and are giving you one dollar's worth of labor for your dollar. Under the day-rate system there is no incentive for the man to do other than plod along from morn till night, day in and day out, doing as little as he can and hold his job. You might drive him, but he is continually grouchy and dissatisfied and you do not get results. How much nicer it is to have a man jump into his work with a will of his own accord, and how much greater the results to all concerned. Under the day work system his highest ambition is to see that he does no more than his fellow-workman. The piecework system sets him to thinking, and figuring out ways and means of accomplishing all he can in the best way he can to promote his and his employer's interests. He knows that he is in a sense an essential part of your organization and that his services are appreciated.

For example: We have at one of our plants a gang of nine or ten men loading trams with ties for treatment. In this gang is one man who will average sixteen trams per day, another who will average fourteen, while the poorest man in the gang averages eight to nine trams. How long would the sixteen-tram man continue to load sixteen trams if his compensation for the day's work was no more than that of the eight-tram man? Why is this man able to load sixteen trams and his co-worker only eight or nine? In this case it is partly due to his superior strength, but in a great measure it is due to his superior ability in other ways to handle ties. He has studied out all the short cuts and knows just how to pick up a tie, how to shoulder it, and how to land it on the tram where it will require the least possible shifting to properly load the tram. To what degree do men become efficient? To illustrate this I will give you the benefit of one or two of my own personal experiences. On this occasion we received an extra heavy consignment of ties in cars that were badly needed for commercial loading. The regular force was not large enough to release these cars as quickly as desired by the management, consequently they diverted two or three extra gangs to help out. The regular men were working piecework at ⅝c. to ¾c. per tie, and averaged from 25c. to 30c. per hour. The extra gang were working for $2.00 per day, and unloaded their portion at a cost of .03½c. to .04½c. per tie. Why this cost? Because the men were working for a stipulated rate of wages, and because they had absolutely no knowledge of how to handle a tie, and furthermore were physically unable to cope with the regular men, due in a great measure to their habits of living. I will leave it to you, gentlemen, to figure out which was the best paying proposition to either the company or the men

The installation of piecework would, of a necessity, need to be worked out to fit conditions peculiar to each individual plant, hence it would be useless for me to attempt to tell you what rates should be applied, but there are several important underlying principles that should apply to all.

First. The selection of competent supervision, or foremen. A man to be a good foreman must be wide awake and energetic at all times. He should be familiar with every detail of the work assigned to him, as also the most practical way to handle ties and timbers so that he can impart it to his men. He should have a knowledge of handling men and be on the ground all the time. He should not be a slave driver, but should be firm and diplomatic in all his relations with his men. These men should understand that his word is law, but if for any reason they deem his demands unreasonable they should be at liberty to put the case up to the general foreman or other higher authority for final decision. In my opinion the superintendent or manager personally should make the final decision, if necessary to carry it that far.

Second. Care should be exercised in perfecting your organization to place your men to the best advantage, and to see that there are no more men in the gang than needed, and yet enough to handle the work without delay to other parts of the organization. You would not hitch a draft horse and a donkey to the same wagon and expect to get efficiency. This is a feature that should be considered in the personnel of your organization.

Third. Schedules should be made to cover each and every operation. These schedules may be based on any of the following units, depending entirely upon your own views and the existing conditions.

Ties—Per tie, or per team loaded.

Lumber, switch ties and crossing plank—Per 1,000 feet boardmeasure.

Piling—Per pile, or per lineal foot.

We have found the following a very good plan:—

Unloading and storing ties on ground—Per tie.

Loading trams for treatment—Per tram.

Unloading treated from trams to cars—Per tram.

Unloading treated from trams to ground—Per tram.

Piling, when handled with derrick—Per pile.

Piling, when handled by hand—Per lineal foot.

Paving blocks—Per square yard.

Lumber—Per 1,000 feet boardmeasure in all cases.

Fourth. In wording your schedules particular attention should be given to the phraseology to see that it is clear, concise and easy to understand, so there will be no chance for any dispute to creep in under the guise of a technicality, and last, but not least, cover all the work which you expect the men to perform under any schedule.

In handling ties and lumber of all kinds a distinction should be made between hard and soft wood as follows:—

Oak or hardwood.

Pine or softwood.

This for the reason that pine or fir weighs approximately three pounds per foot, while oak weighs five pounds per foot. You would not expect any man to handle 5,000 pounds for the same price as 3,000 pounds.

A competent man should be selected to make the schedules and establish the rates of pay. In order to get the best results he should have a knowledge of handling men and material. He should be competent to recommend practical changes or improvement of conditions, tools or other devices that will facilitate the handling of the ties or timbers. Oft-times a dollar judiciously spent to improve conditions means many in return. In establishing prices it is important that all the facts and figures bearing on the operation be accumulated in order that prices may be established on an intelligent basis. To accomplish this the party getting the in-

formation should be on the ground personally, watch the operation from start to finish, and make notes as to number of men, kind of material handled, how handled, time consumed by each man, degree of efficiency, or anything else that would have an important bearing on the wording of the schedule or the base rate. Prices should be based on three things: the authorized hourly rate, degree of efficiency obtained under the day rate system, and the conditions and tools furnished.

All prices should be made on a basis that is fair to the employer and the employee. Once a price is established it should never be changed unless there is a change in conditions. Suitable blanks should be provided for keeping the time and checking material in and out. These will be turned in to the timekeeper daily to figure up and enter on the pay roll.

In establishing piecework a good plan is to start in with some one gang. Advise them daily of their earnings and arrange it so that the rest of the men working on a day rate will know what this gang is earning. They will immediately begin to get interested and ask for the piecework system, and in a short time your entire force is working on the piecework basis. There will perhaps be days when, due to some peculiar unforseen condition or nature of the material, the men will fall below their former day rate, while there will be other days when they will do exceptionally well, hence only the average for the month would be a fair comparison.

Foremen should be on a monthly basis, the rates to be fixed according to your own ideas. In no case should a foreman have supervision over more than twelve men, and eight or nine men is better, in my opinion, when handling ties or lumber by hand. The duties of the foreman are to instruct his men what to do, give them the benefit of his experience in handling material, keep them supplied with work at all times, see that it is properly done, and keep track of their time and material handled, checking same personally in all cases.

When unloading ties to season, also loading trams for treatment, each man works as an individual. When handling treated ties the men generally work in pairs or gangs of three, each man getting an equal proportion of the earnings of the gang. If a man is taken out of the gang during the day and another put in his place, the foreman should take proper record so that the earnings can be properly apportioned. With us when unloading ties to season no effort is made to sort them. The sorting as to kind of wood and grade is done when loading them to trams. When unloading switch ties by hand we find four men to the gang the best, and handling switch ties, piling and lumber with a locomotive crane three men in addition to the engineer. In all cases I would advocate the same rate from start to finish of an operation, unless some unusual condition arises. The man gets the same for the last tie as for the first.

There is a maximum to all things when efficiency is considered. In storing ties to season, piling them eight to one, the maximum height of the pile should be sixteen to eighteen feet. Treated ties when piled on the ground should be in solid square piles eight to ten feet high.

It has been said that ties and timbers cannot be properly piled under the piecework system. In this connection I would invite your attention to some photo views which I have taken at our Galesburg plant showing what we accomplish under this system. These photos are representative views of our entire yard, not a pile here and there. I would call your particular attention to the symmetrical piles, both from a side and end view, as also the alignment of the piles. Look them over and decide for yourself whether or not ties and timbers can be properly piled under this system.

Someone has said that the efficiency of a timber-treating plant should be based on the number of retort hours worked out of the total possible retort hours. In obtaining efficiency in plant operation the fact must not be lost sight of that good and effective treatment is the first or primary object, and at the same time your supervision, your organization, and your system of physical handling must be the best possible. This is what we claim to have under the "piecework system." During the year 1912 at our Galesburg plant we obtained on the above basis 98¾ per cent. efficiency, or, in other words, each of the three retorts were in actual operation 98¾ per cent. of the time. This means that out of a total of 7,488 possible retort hours for each retort they were operated 7,394.4 hours, holidays excluded.

Efficiency is a watchword, and the day is now at hand when the railroads, the corporations and the business man in all lines expects and demands efficiency. This demand is growing every day, each year we are expected to do better than we did the previous year until we have reached the limit, and unless you and I, or whoever is held responsible, get in "the efficiency band wagon," we are going to wake up some day and find someone else occupying our seat.

PRESERVATION OF LUMBER FOR CAR CONSTRUCTION.*

By J. H. Waterman.†

I have been requested by your committee on programme to write a paper on the above subject. I have compiled a few facts for you, but before I give you the facts I want to say that my observation leads me to make the statement that treating lumber with creosote for car construction will be necessarily limited, on account of the fact that it is impossible to paint timber, or rather impractical, after it has been creosoted. Most roads in this country have a standard color for their cars, and they would not want to change that color to black in order to please the wood preservers of this country. If any road should desire to change their stock cars to a standard black, then the creosoted timber would be the ideal, for they would be permanently painted, providing the timber was framed before it was treated, and as they are used for taking stock to the market, which means the grave for the stock, why not advocate painting all the stock cars in this country black. It would be a good color, if it did remind you of a funeral train as it went by.

So far we have treated only car sills and car decking.

Fir Car Sills.—To date we have treated a total of twenty-three runs.

We succeeded in getting an average absorption of 11.41 lbs. per cubic foot.

Board feet treated, 326,204.
Average steam pressure, 15 pounds.
Average time steam, 2 hours 23 minutes.
Average initial vacuum, 23 inches.
Average initial vacuum held, 1 hour 37 minutes.
Average solution pressure, 175 pounds.
Average solution pressure held, 17 hours 26 minutes.
Average final vacuum, 20 inches.
Average time final vacuum, 1 hour.

Fir Car Decking.—To date we have treated a total of thirty-nine runs.

* Abstract of paper delivered before the American Wood Preservers' Association.

† Supt. Timber Preservation, C., B. & Q. R.R. Co.

We succeeded in getting an average absorption of 14.33 lbs. per cubic foot.

Board feet treated, 1,013,472.

Average steam, 15 pounds.

Average time steam, 57 minutes.

Average initial vacuum, 24 inches.

Average initial vacuum held, 1 hour 6 minutes.

Average solution pressure, 175 pounds.

Average solution pressure held, 13 hours 10 minutes.

Average final vacuum, 21 inches.

Average time final vacuum, 1 hour.

The Fir Car Sills.—In the sap wood we got a thorough penetration; in the hardwood not to exceed one inch all around.

In the car decking, when it was dry, it was thoroughly penetrated with creosote. I presume you all understand that car decking is 1¾ inches thick.

Our people feel that it is not only practical, but that it pays, to treat the car sills and car decking for stock cars. You all realize that it would be impractical to treat car decking for box cars on account of the odor. They could not be used for flour and many other lines of merchandise, which would absorb at least the odor from the wood if treated with creosote. We never can look for a very broad field to operate in so far as treating car lumber goes. However, I believe it is practical to treat car decking for stock cars and flat cars. For stock cars it also acts as a disinfectant, and from that point it would be not only practical but, I believe, effective, and the roads that are using lumber for car sills, there is no question but what it would lengthen the life very materially. How much I am not able to say, for we have only practiced treating car sills and car decking for about one year.

All of our new stock cars now that we build with wooden sills we treat the sills and all of them we treat the decking.

I would recommend that the president appoint a standing committee to go into carefully, not only the treating of car sills, but the treating of any and all timber which would be practical, and by that means the field for treating timber will be broadened and strengthened, and the committee should have power to make recommendations, and we, as the American Wood Preservers' Association, should stamp our approval or disapproval on what they recommend. And, gentlemen, I believe it would have weight in the commercial world, and what are we here for if we do not further our own interests and conserve the forests of our country by getting the longest possible life out of all wood that is used.

THE REQUIREMENTS FOR SUCCESSFUL TIMBER TREATMENT.*

By Hermann von Schrenk.

Treated timber has been used in the United States for a sufficient number of years so that we are beginning to obtain some results. As is the case in every other industry, some failures are becoming evident in various parts of the country. During the last year I have spent a good deal of time investigating the reasons for failures of pieces of so-called treated timber. I say so-called treated timber advisedly. In discussing the causes for failure of the cases referred to with a number of persons interested in wood preserving, it was suggested that I say a few words about the general subject of successful timber treatment to the members of this association. I do this with the feeling that there is probably no subject in which we are more vitally interested than to see to it that the results of our labors give satisfactory returns to everybody concerned.

Timber treatment has grown so rapidly in the United States that the amount of material actually treated every year is ten times what it was seven or eight years ago, and the number of men engaged in the industry has correspondingly increased. As the use of treated wood has increased, inevitably some conditions have arisen which I believe it is well for us to consider. In the early days of timber treatment there was a good deal of experimenting as to methods, and, for that matter, there is still some experimenting, but, as the result of some twenty years' experience, some facts are sufficiently well known at the present time to all of us, and these facts have become more or less axiomatic. Briefly stated, in order to get good results from treated timber the following points must be observed:

1. Only perfectly sound timber should be treated.

2. In order to obtain the best results, properly seasoned material should be used.

3. A good preservative is essential to long life.

4. Proper injection as to quantity and penetration is essential.

5. Proper subsequent handling of the timber is essential.

In my investigations I have found that the premature failures of so-called treated timber were almost without exception due to the non-observance of one or more of the above principles. I am perfectly sure that in the early days a good deal of timber was treated which was sap rotten. It was not realized ten years ago, as it is to-day, that timber may be very badly decayed in the interior and yet show absolutely no evidence on the outside. With the best intentions, therefore, many sticks of wood were doubtless treated which we would unhesitatingly throw out to-day. Many of the failures were, however, due to the fact that timber was treated because of certain contract requirements and in spite of a better knowledge of the person responsible for the actual treatment. The lessons to be drawn from failures are very obvious, and I believe we should take cognizance of them, particularly in view of more thorough knowledge of all the factors surrounding the operations which make for successful treatment.

While there is no doubt very general agreement among the men engaged in the timber-preserving industry as to the fundamental conditions enumerated above, we all know that frequently, under stress of business circumstances, they are not always adhered to. The consumer frequently makes demands which cannot be fulfilled, and if they are they are bound to result in speedy and ultimate failure.

The inspection of material before treatment should be made with greater care. I believe that every treating company should be empowered to refuse to treat material which they know to be defective. In other words, I do not think that anyone is warranted, under any circumstances, to treat material which he knows to be unfit because of various defects. A defective stick was never improved by any kind of treatment.

The same holds true for improperly seasoned material. The excuse is frequently given, in demanding treatment of absolutely green material, that emergencies have arisen which necessitate such treatment, or some similar explanation is given. Unfortunately, with the increased use of timber in its various forms, the tendency to require and do such rush work seems to me to be increasing. It is frequently inconvenient to wait six or eight months, or more, to properly season material; besides, it costs considerable for interest charges.

That which has been said for the inspection of the material before treatment holds equally for the preservative used and the manner of treatment. How much service do you suppose will be obtained by treating green red oak ties with two gallons of creosote oil by the full-cell process? We all

* Abstract of paper delivered before the American Wood Preservers' Association.

know that the penetration of timber so treated is insignificant and that internal sap rot is bound to occur in comparatively short periods of time.

I may be treading on delicate ground when I refer to the relation which should exist between a treating company and its customer. I have no hesitation, however, in saying that I believe it to be the duty of the man who knows how timber should be treated (because that is his business) to protest vigorously against any requirements which necessitate his treating a customer's material in a manner which he knows to be wrong. I wish to protest against the tendency which requires the actual treating operation to be conducted in accordance with any demands which may be made by the customer, because not only does this give disappointing results so far as any particular piece of work is concerned, but also because it reacts on the company doing the work and on the industry as a whole. The people as a whole are apt to forget that when the piece of so-called treated material fails, that that particular piece of material was treated under unusual conditions, no matter how much these conditions may have been justified at the time. I wish to protest against the "necessity" tendency to do rush work. We might as well face the problem now and say that successful treatment of timber can only be accomplished by observing certain laws, and that when one or more of these laws are broken, the consequences will be swift and certain. If I had the opportunity I could demonstrate the truth of this statement to anyone interested, and all I would have to do would be to show him some choice samples of so-called treated timber, which I have in my possession, which failed after three or four years' service, and explain why it failed, and then point to work well done, with twenty to thirty years' service behind it.

I have referred in this brief manner to what appears to me a very important situation affecting the timber-preserving industry at this time, and as one interested in the timber-preserving industry, and anxious to see timber last, I speak also as one anxious to see those engaged in this industry put into a position to carry out its basic principles. I know that there are difficulties which both the consumer and the timber-preserving company have to meet, and, as in all other affairs, that there are emergencies which will warrant doing exceptional things. I know also, however, that frequently requirements are made in the best of faith which it is hard to object to. I believe it would be perfectly proper for this association, standing as it does, for all that is best in the wood-preserving industry, to give expression to some of the sentiments herein expressed. I would favor the passage of some resolution emphasizing the necessity for a careful observance of the principles referred to. I am sure that a strong statement coming from this representative organization would be of the greatest service in giving a proper appreciation of what the wood-preserving industry as a whole stands for.

NEW STEAMER ORDERED.

The Collingwood Shipbuilding Company has been awarded a contract for a combined passenger and freight steamer by the Pelee and Lake Erie Navigation Company, which operates between Pelee Island and the mainland ports including Rondeau. The new steamer will be constructed of steel and will be 145 feet long with 24 feet beam and a depth of 18 feet 3 inches. It will be a day boat and will be fitted up specially for the route on which she will ply. The motive power will consist of triple expansion engines, 12½, 21, 34 inches with a stroke of 21 inches. This will be supplied with steam by one Scotch boiler 12 feet 6 inches in diameter and 10 feet 6 inches in length. The steamer will develop a speed of thirteen miles per hour. The contract calls for delivery in July next.

TORONTO RAILWAY COMPANY.

The gratification of a shareholder who was present at the annual meeting of the Toronto Railway Company this week, at the excellent financial statement presented by the directorate, was apparently disturbed by prospects of civic competition. Mr. Fleming, the general manager, however, quieted those fears, merely pointing out the heavy loss at which the short existing civic lines were being run. Every street railway is trailed by an army of critics. Mr. Fleming told his shareholders, and incidentally the army, that the Toronto system is one of the best on the continent, and we think that fair-minded critics will agree with the statement.

The gross earnings last year amounted to $5,448,050. Deducting therefrom charges of $2,866,550 for operating, maintenance, etc., the net earnings were $2,581,500. Several substantial payments were made from that sum, the heaviest being to the city and amounting to $942,048, while $879,595 represented dividends to the shareholders. Bond interest, etc., absorbed $190,992. The payments to the city were greater by $119,815 or 14.6 per cent. than in the previous year.

The progress of the company in recent years is shown in the following table:—

	1902.	1908.	1912.
Gross income	$1,834,908	$3,610,272	$5,448,050
Operating, maintenance.	1,015,361	1,889,046	2,866,550
Net earnings	819,547	1,721,226	2,581,500
Passengers carried	44,437,678	89,139,571	135,786,573
Per cent. of charges to passenger earnings .	55.3%	52.9%	58.4%

The Toronto and York Radial Railway Company report that their earnings continue to show satisfactory increases, the gross earnings amounting to $492,922, compared with $449,059 for the previous year—an increase of 9.76 per cent.

OTTAWA ELECTRIC RAILWAY.

The shareholders of the Ottawa Electric Railway Company have every reason to be pleased with results of operations for the year ended December 31st, 1912. The gross earnings were $934,397, an increase of $93,717 over the previous year. The net earnings were $400,059. Out of that sum, four quarterly dividends of 3 per cent. and a bonus of 3 per cent. were paid, being a distribution to shareholders of $255,947. The gratification of the shareholders was further strengthened by the prediction of Mr. T. Ahearn, the president, that the prospects for the coming year are of the brightest character.

The growth of the company in the past few years is clearly shown in the following table:—

	1893.	1903.	1912.
Gross receipts	$110,071	$348,888	$934,397
Total expenses	70,221	254,346	578,540
Net income	39,850	94,541	355,856
Passengers carried	2,394,504	7,911,718	21,815,798
Per cent. of operating expenses to receipts		61 4-5%	57 1-5%

After the payment of dividends and bonus last year, the substantial sum of $69,000 was placed at the credit of contingent account to be applied to the reduction of track renewal, car equipment and other accounts. Interest on bonds and loans absorbed $21,303; mileage payments, $13,435, and taxes, $9,463. There remained a sum of $30,908 for transference to credit of profit and loss account. The balance at credit of that account is now $138,264 and at the credit of rest account $200,000. Several important improvements were made to the company's system last year, by which the earning capacity and facilities for handling the increasing traffic will be greatly augmented.

NOTES ON STAKING OUT TRACK CONNECTIONS.

The solution of maintenance engineering problems in railway work is well treated in an article published in the January 24, 1913, issue of the Railway Age Gazette. This article is written by W. H. Wilms, and is here given in full.

The ordinary field book is of slight value to the engineer engaged in maintenance work in the solution of track problems. None of the problems presented in such books have been solved with a view to practical application. Following the methods outlined in these books, it is not uncommon, for instance, to see new sidings staked with the initial curve tangent to the centre of the track from which the turnout leads, although a little study will show that the curve is not necessarily tangent to the frog, and unless it is tangent, an elbow must be thrown in the curve, or a piece of tangent introduced, depending on whether the curve beyond the frog is of less or greater degree than the curve back of the frog. In either case, the siding presents a bad appearance and in case of an extremely sharp curve and close quarters, the engineer would probably find the siding could not be operated until relocated. The only field book that has attempted to treat track problems with a view to practical application by means of a so-called "reference curve" makes such problems really more complicated than they are. In the following notes only such problems as commonly occur in practice are given, leaving it to the ingenuity of the engineer to modify these methods to meet his particular requirements in more complicated cases. While no claim to originality is made in the solution of these problems, it is believed a number of them will be new to not a few engineers.

Switch Leads.—From both the operating and maintenance standpoints the installation of turnouts leading from curves is to be avoided whenever practicable. When the installation of a turnout on the outside of a curve is unavoidable, the switch leads should be made straight wherever it is possible

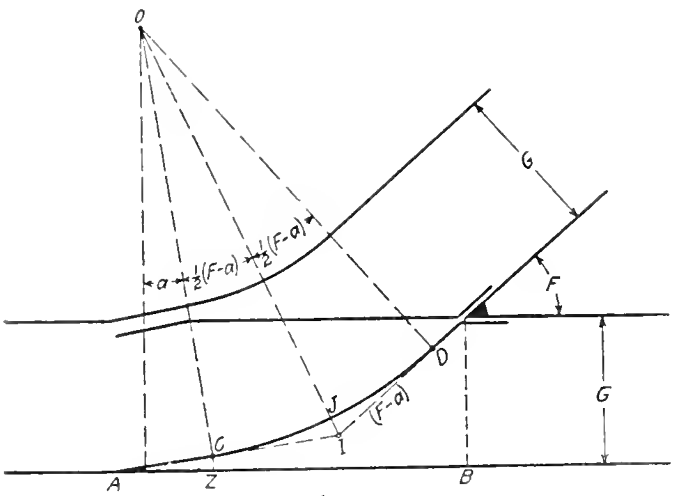


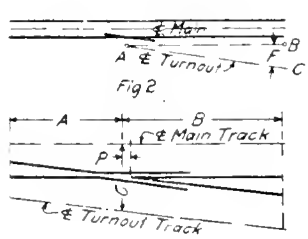
Fig. 1.

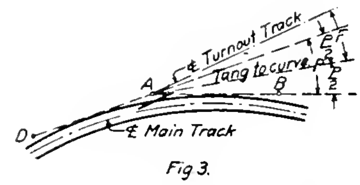
to do so, as the benefits in safer operation and decreased maintenance of the switch by using straight leads are very pronounced. Often a slight change of alinement or the substitution of a different size frog will readily effect this.

Of equal importance is the reduction to a minimum of the curvature in the leads of a turnout on the inside of a curve. This also can often be effected by slight changes in alinement and the substitution of a higher frog number.

Also, for similar reasons, the alinement of the turnout track immediately beyond the frog is of importance. Where a curve is necessary it should, if possible, be of the same degree as the curvature in the lead; otherwise there results the objectionable feature of a change in curvature in a very bad place, which not only looks bad but is apt to be a constant source of trouble in operation and maintenance. This is especially true where the curvature is sharp and connections close.

In order to obtain a solution to such problems as the above where the alinement of the switch lead is taken into consideration, it is quite necessary to know the actual length and degree of curve of the leads of the road's standard turnouts from straight track. Knowing the length of switch rail,





No	Angle	A	B	C	D	p	Lead

Fig. 4.

spread at heel of switch and length of frog from theoretical point to toe, the length and curvature of the lead are readily obtained from the following formulas:

(From Manual of Am. Ry. Eng. Assoc.).

F = Frog angle
W = Length of wing rail of frog
S = Length of switch rail
H = Heel distance of frog
G = Gauge of track
R = Radius of centre line of lead curve
a = Switch angle

$$\text{Lead dis. AB (Fig. 1)} = (S - W)\frac{\sin \frac{1}{2}(F - a)}{\sin \frac{1}{2}(F + a)} + G \times \cot \tfrac{1}{2}(F + a)$$

$$\text{Radius of lead curve} = \frac{G - H - W \times \sin F}{\cos a - \cos F} - \frac{G}{2}$$

Having once computed this data from the road's standard frog numbers, the engineer should place it in his field book for future reference.

Significance of Stakes.—Due to the fact that many track foremen and supervisors have to work to stakes set by many different engineers, some of whom make it a practice to set stakes indicating the location of a frog on the rail line at the theoretical point and others who set such stakes on the centre line of track opposite the actual point, costly mistakes sometimes result. To avoid such trouble, it is a good plan to have some definite system of marking and setting stakes, and after the tracks have been staked out to go over the layout with the track foreman and explain to him the significance of the stakes, so that when track laying begins there will be no chance for mistake or confusion. In most cases it is unnecessary to take into consideration the difference between the theoretical and actual points in the location of a frog. There are a few cases, however, where a failure to observe this difference would result seriously. For example, in the location of the frogs of a No. 10 crossover between parallel straight tracks, 13 ft. centre to centre, where the track is straight between frogs, the distance from theoretical to actual point of a No. 10 frog with a ½-in. point is 5 in. Now, if stakes are set for theoretical points and the foreman sets the actual point of frogs to these stakes—a thing he is very likely to do unless the significance of the stakes has been explained

to him—there will result a total error in the position of the two frogs of 10 in., resulting in a gauge of only 4 ft. 7½ in. in the straight track between the frogs. This is no hypothetical case, but along with other mistakes of its kind is almost of constant occurrence with young and inexperienced engineers. To avoid such trouble, stakes marking position of frog should be set for actual point and plainly marked to that effect. When the location of a frog in the existing track

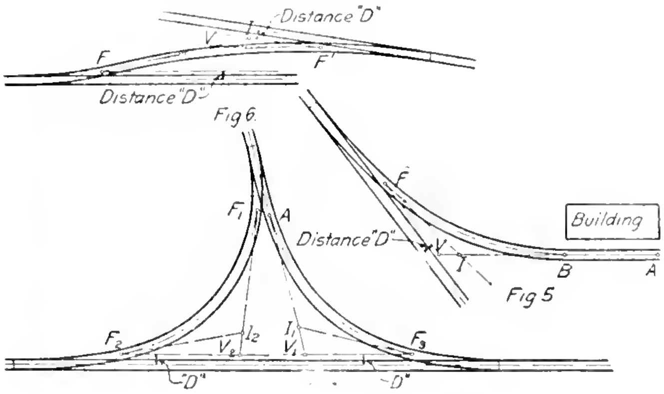


Fig. 7.

is not definitely fixed by conditions, the point of the frog should be so located as to bring the heel or the toe at a rail joint. If this is done, only one rail cutting is necessary and no short rails are required.

Graphical Solution of Track Problems.—A great many track problems can be readily solved by graphical methods. With careful and accurate drafting on a large scale—say 10 or 20 ft. to the inch—many complicated problems are readily solved with all the accuracy usually required in track work. In a great many problems a solution can be easily and quickly effected by making a few trials in the field. In such cases it has been the writer's practice to carry with him in the field a few curve templets, scale, triangle and drawing paper, and by locating the critical or determining points and plotting them to scale, he has generally been able to decrease the number of trials necessary for a solution to one or two.

In staking out tracks to and around existing structures the young and inexperienced engineer may not appreciate the importance of proper clearance and many a track has been staked and afterwards built 6 in. to a foot or more too close to an existing structure.

General Methods.—The ordinary method of locating turnouts where the position of the frog in the main or body track is not a critical feature is as follows: Set up the instrument at A (Fig. 2), this point being in the centre line of the turnout track opposite the point of the frog. Foresight is taken on point B gauge distance from the centre line of main or body track, with the vernier set at minus the frog angle so that when the reading is turned to zero the line of sight is in the centre line A-C of the turnout track. If, now, the turnout track is to proceed on a curved alinement, deflections may be turned either right or left and the curve located. A stake set back a distance from A equal to the length of the lead locates the switch point and the track foreman lines the curve between the heel of the switch and the toe of the frog, either by eye or by using a series of ordinates from the main track rail. If the main or body track is curved (Fig. 3), a backsight D and a foresight B are set, making the distance A-D equal the distance A-B. The angle between the line A-B and the line D-A extended is bisected to obtain a line parallel to the tangent to the main track rail at the point of frog and the frog angle F is then turned off from this tangent line. The work of locating the turnout track is thus done with one set up of the instrument, entirely independent of any theoretical assumption regarding the curve in the lead.

To make the curve (if any) in the turnout track tangent at the heel of the frog instead of at the point, which many would consider better practice, it is only necessary to have a table as in Fig. 4, and using the offset D, proceed as before.

In locating close connections between tracks and sharply curved branch tracks running into or along buildings where the exact position of the frog is a critical feature of the work, this position may usually be obtained as follows: Let A-B (Fig. 5) be the centre line of a branch track whose position for the distance A-B is determined by the building. Extend line A-B towards the main track to point V at distance D from the centre line of the main track. Measure the angle V and the distance VB. Let I be the point of intersection of the line AV with the line FI, angle IFV being the frog angle. Now the criterion for the minimum degree of curvature in the curve FB is that the point of intersection I shall be equally distant from the points F and B. This makes the curve FB a simple circular curve. To solve the problem, let FI = IB = T and let measured distance BV = M.

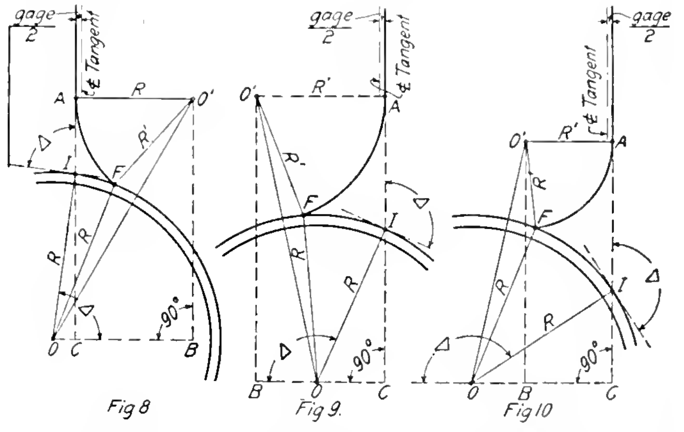
Then VI = M — T: and in triangle FIV we have:

Angle I = angle V + angle F, and

$$\frac{T}{\text{Sin } V} = \frac{M - T}{\text{Sin } F},$$

from which the tangent distance T may be obtained. After thus solving triangle FIV, first for T, then for distance FV, the frog may be located by measurement from the established point V. This method of treatment is applicable to crossovers between non-parallel tracks (Fig. 6), to wye tracks (Fig. 7), and to crossovers between parallel tracks where frogs or unequal angles are used.

In applying the problems, as found in the field books, where a turnout from a curved track is to form a connection with an established tangent, the engineer is restricted to the use of but one curve, the degree of which is that of the theoretical curve of the turnout, which equals the degree of curve of turnout from a straight track, plus or minus the degree of the curve of the track from which the turnout springs. The use of this one curve will rarely prove desirable on account of its being either too sharp or too flat.



[Case 1. Curves in Opposite Directions. Δ less than 90°.] | [Case 2a. Curves in Opposite Directions. Δ greater than 90°, R¹ greater than R cos Δ.] | [Case 2b. Curves in Opposite Directions. Δ greater than 90°, R¹ less than R cos Δ.]

Four general cases of the problem present themselves, as shown in the illustrations, Figs. 8, 9, 10, 11, 12, 13. The necessary field work in each case consists in measuring the angle between the centre line of tangent and the tangent to the centre line of the curve at the point of intersection; or better yet, the angle between a line offset one-half the gauge from the centre line of the tangent and the rail which will

pass through the frog, as the latter will simplify the problem, and the radius of the rail is determined simultaneously by measuring the middle ordinates for one or more chords.

Having the angle of intersection, as described above, the radius of the curved track, and the angle of the frog to be used, and having selected a radius for the connecting curve, the essentials of the location are the distance between the point of intersection and the point of the frog, the central

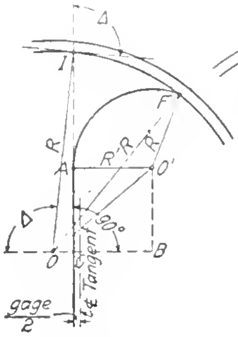


Fig. 11.

[Case 3. Curves in Same Direction. Δ greater than 90°.]

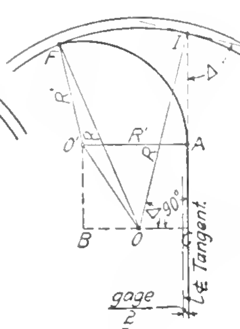


Fig. 12.

[Case 4a. Curves in Same Direction. Δ less than 90°. R^1 greater than $R \cos \Delta$.]

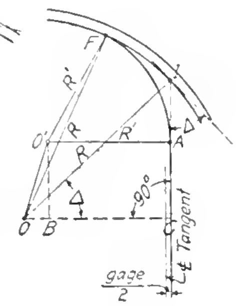


Fig. 13.

[Case 4b. Curves in Same Direction. Δ less than 90°. R^1 less than $R \cos \Delta$.]

angle of the connecting curve and the distance between the point of intersection and the B. C. of connecting curve.

The following solutions offer ready and accurate methods of obtaining the above-named points:

In Figs. 8, 9, 10, 11, 12 and 13 let CA represent a line offset one-half the gauge from the centre line of tangent, which is to be connected with the gauge line of the rail of the curved track by means of a frog having an angle of F and a curve whose radius is R. O and O^1 are the centres, I the point of intersection where the angle Δ has been measured, and the other notations are as shown in the diagrams. The rail opposite the frog and the switch rails are not shown as they have no bearing on the problem. Required to determine the angle I O F. Then measure on the curve:

Arc F I = R $\times$ angle I O F in minutes $\times$ a constant ($=$ 0.00029089).

Or chord F I = 2R $\times$ sin ½ I O F.

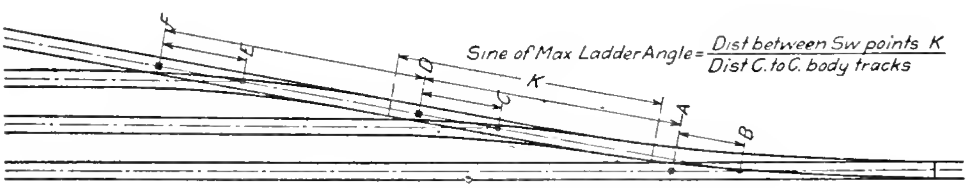


Fig. 15.

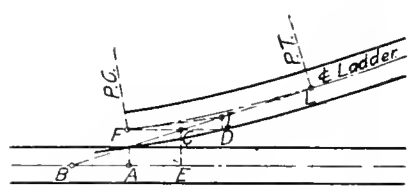


Fig. 16

The distance OO^1 is determined by solving the triangle OFO^1 of which the angle F and its including sides R and R^1 are known. This also determines the angles FO^1O and FOO^1.

In cases 1 and 3, Figs. 8 and 11, $O B = B C + O C = R^1 + R \cos \Delta$

In cases 2a and 4a, Figs. 9 and 12, $O B = B C - O C = R^1 - R \cos \Delta$

In cases 2b and 4b, Figs. 10 and 13, $O B = O C - B C = R \cos \Delta - R^1$.

It should then be noted that when O B is computed to be greater than O O^1, impossible conditions have been imposed; the radius of the connecting curve has been taken too large.

Having determined the angle O^1 O B from the right triangle O B O^1, in which O B and O O^1 are known, the angle I O F is found as follows:

In cases 1 and 2a, $I O F = \Delta - (F O O^1 + O^1 O B)$.
In cases 3 and 4a, $I O F = 180° - (\Delta + F O O^1 + O^1 O B)$.
In case 4b, $I O F = O^1 O B - (F O O^1 + \Delta)$.
In case 2b, $I O F = \Delta - (180° - O^1 O B + F O O^1)$.
In cases 1 and 2a, $A O^1 F = O^1 O B - F O^1 O$.
In cases 3 and 4a $A O^1 F = F O^1 O - O^1 O B$.
In case 4b, $A O^1 F = F O^1 O - (180° - O^1 O B)$.
In case 2b, $A O^1 F = 180° - (O^1 O B + F O^1 O)$.

To determine the distance AI:

In cases 1 and 2, $A I = A C - I C = O^1 B - I C$, $= O^1 O \sin O^1 O B - R \sin \Delta$.

In cases 3 and 4 $A I = I C - A C = R \sin \Delta - O^1 O \sin O^1 O B$.

The engineer should be careful to add or subtract one-half the gauge to the centre line radii, as the case may require. The point A which is the B C. of the connecting curve, and the point F, which is the theoretical point of frog P. T. of the connecting curve can now be readily fixed in the field and the entire connection staked out.

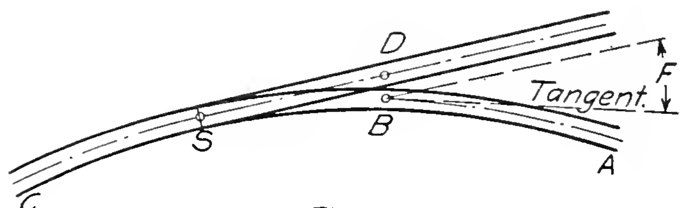


Fig. 14.

While the writer realizes that it is better practice to place the frog end of the connecting curve at the heel of the frog, to impose that condition in the above problem would complicate it beyond measure. In inserting 10 or 15-ft. frogs in a curved track, the trackmen cannot help slightly changing the original alinement of the track at that point, and energy spent in making a closer solution than that outlined above will surely be wasted.

Method of Obtaining Straight Leads.—Theoretically, a turnout leading off the outside of a curve, the degree of which is equal to that for the turnout from straight track will have a straight lead. Practically, however, the lead will not be straight, but curved to a greater or less extent. This is due to the fact that switch rails and frogs are straight and not curved as is generally assumed. When it is possible to do so, it is desirable from both the operating and maintenance standpoints to obtain absolutely straight leads. To obtain straight leads in turnouts leading off the outside of a curve where the main curve is also being staked at the same time, the following method will prove effective. (See Fig. 14).

After staking out the main curve ABC to B, the point decided upon for the location of the frog, set up the instrument at D, this point being in the centre of the turnout track opposite the point of frog. The frog angle is now turned off from a line through D parallel to the tangent to the curve at B, and the point S is located a distance equal to the length of the switch lead from point D. The instrument is now set up at S, and the main curve is continued from the line DS, or switch lead, after which the alinement of the turnout beyond the frog can be proceeded with.

Where conditions permit, it is desirable to have the alinement of crossovers between frog points straight. In the case of crossovers between parallel curved tracks, it is not generally possible to meet this requirement using standard frog numbers, a special frog being necessary in such cases. The writer has known of a number of instances where this requirement of straight track between the frogs of a crossover was of sufficient importance to justify the ordering of the special frog necessary, frog points being comparatively close together in most crossover work.

Ladder Tracks.—In order to obtain the maximum car capacity of the body tracks connected to a ladder track, the angle of the ladder track should be made the greatest possible under the conditions. The criterion for maximum ladder angle is given by the formula (see Fig. 15):

$$\text{Sine of maximum ladder angle} = \frac{\text{Distance between switch points K}}{\text{Distance centre to centre of body tracks.}}$$

In order that road engines may operate over the ladder track it is desirable that the curve beyond the main track frog be made as light as possible. In a number of extensive ladder layouts the writer has used two and three degree curves in such places with very good effect. The method of staking out such ladder tracks is as follows:

After locating the position of the main track frog the point of intersection of the centre line of the ladder track with the centre line of the main track, B, is found by measuring off the distance AB. The instrument is set up at B, the ladder angle turned off and the frog points along the ladder located by measuring the computed distances from B. At the same time the points of intersection of the centre line of various body tracks with the centre line of the ladder track are located by measuring the distance DC, FE, etc., from the frog points. The curve beyond the main track frog is now located. The instrument is then set up at the points C, E, etc., and the body tracks staked out by foresight established at the opposite ends of these tracks by measuring over the respective track centres of each track from the main track. The curves connecting the various body tracks to the ladder track being very short, it is sufficient to locate only their middle and end points.

To compute the distance AB (Fig. 16), let

T = Tangent distance of curve FL
ICD = Ladder track angle

Then

$$\begin{aligned} DI &= T \sin F \\ FD &= T \cos F \\ CD &= DI \cot ICD \\ FC &= FD - CD \\ AB &= BE - AE \\ &= \text{gauge} \times \cot ICD - FC. \end{aligned}$$

While the writer believes that the above method of laying out ladder tracks represents the best practice, there are a number of engineers who prefer to make the ladder angle equal to the angle of the frog to be used in the ladder track, thus making the ladder track frogs line up straight with the body tracks. The central angle of the curve beyond the main track frog is then simply the difference between the angles of the main and ladder track frogs. However, the writer sees no justification in sacrificing valuable ground space and consequent car capacity for the little, if any, advantage that is gained by eliminating the slight curve beyond the ladder track frogs. Those who favor this method claim that by the elimination of this curve in the body tracks, switching operations are rendered more safe by reason of the better views afforded trainmen. However, the writer believes this apparent advantage is more imaginary than real.

CONTROL AND REGULATION OF NIAGARA RIVER.

Hearings were held on January 22 and 23 before the United States House Committee on Foreign Affairs on the new bill controlling the diversion of water on the American side of the Niagara River and the importation of electricity from Canada. The Burton Act expires by limitation on March 4, and a fight is in progress to take from the federal government the control of the diversion of water in navigable rivers and, in the Niagara Falls case, vesting it in the State of New York. The Secretary of War has appointed a board to report upon the problem of diversion of water from Niagara Falls, consisting of Lieutenant-Colonel Mason M. Patrick, Colonel Francis J. Kernan and Major Charles Keller, all of the Corps of Engineers, U.S.A.

The treaty between Great Britain and the United States authorizes the United States to permit the diversion of not more than 20,000 cubic feet of water per second, while the Canadian government is empowered to authorize the diversion of not more than 36,000 cubic feet per second. At present the diversion on the American side of the Niagara River aggregates 15,600 cubic feet per second. The bill now before Congress does not permit the diversion of any more than that amount, and whereas the Burton Act permitted the importation of a maximum of 35,000 h.p. from Canada, the present bill limits the amount to 200,000 h.p. It also makes it obligatory for the generating companies to utilize the water at its maximum efficiency and stipulates that the companies receiving permits for the transmission or delivery of electrical energy shall be regulated to rates, etc., by the Public Service Commission of the State, or where such a commission is lacking by the governor of the State.

At the hearing on January 22 the State of New York through its attorney-general claimed, after the government has decided how much water may be diverted from the Niagara River, that it is entitled to control the diversion of the water and to decide the parties to whom it shall go. It was contended that while the federal government has a right to determine the quantity of water that may be diverted from a boundary stream in the exercise of its constitutional rights to control navigation, that power is exercised pursuant to that constitutional right only for the purpose of regulating and controlling navigation and for no other.

The president of the New York State Conservation Commission expressed opposition to any legislation which will permit the existing generating companies to get any additional water from Niagara Falls. He said that the present policy of the State is to utilize all the undeveloped water-powers for the benefit of the people generally. The generation of electricity which is to be transmitted to the various municipalities and through them to the ultimate consumer at practically the cost of its development. He also maintained that true conservation presupposes the utilization of all the water permitted by the treaty at its maximum efficiency.

It was brought out at the hearing that the taxes of the Niagara Falls Power Company to the State and municipalities aggregate \$3 per horse-power, while the Canadian government charges practically \$1 per horse-power. The Cataract Power and Conduit Company, which distributes Niagara energy in Buffalo, pays the Niagara Falls Power Company \$16 per horse-power-year and sells it at practically \$25 per horse-power-year, the difference being used to pay all the charges of transformation and transmission to Buffalo and its distribution in that city. The Hydro-Electric Power Commission of Ontario pays \$9.40 per horse-power-year for energy to the Ontario Power Company delivered at the terminals of the transforming apparatus, or practically at the power house.

It was also pointed out that the Ontario Power Company generates 17 h.p. for every cubic foot of water per second that is used, whereas the Niagara Falls Power Company is able to generate only about 11½ h.p. for every second-foot of water used.

NEW BUILDINGS OF THE CANADA FORGE COMPANY.

The Canada Forge Company, Limited, Welland, Ont., are rushing to completion a temporary building to replace the one recently burned, and will positively have a part of their forge department in operation within a week, which is record time. This quick work will enable them to satisfactorily care for the delivery requirements of their many customers.

This building will be covered within ninety days by a modern fireproof steel construction forge shop of the most advanced type, contract for which has been placed with the Standard Steel Construction Company, and especially designed for the manufacture of forgings up to 40,000 pounds in weight each.

The general dimensions of this building will be 100 feet by 200 feet, with centre bay equipped with 20-ton electric crane 60-foot span, with two bays each to be served with five-ton electric crane, 20-foot span.

At the end of this building and continuing a distance of 100 feet, there will be constructed a 60-foot span electric crane runway 20-ton capacity for handling raw materials and shipping.

This will not only insure the company against further interruptions in their production, on account of fire, but will greatly increase the scope of their work; and equipped as it will be with steam hammers, hydraulic forging presses, annealing and heat treating furnaces, it will be one of the finest forge shops on this continent.

WANT SHIPBUILDING ENCOURAGED.

A deputation, representing shipbuilding interests from coast to coast, has waited on Premier Borden. They state that the Canadian shipbuilding industry, in which twenty million dollars are now invested, will go out of business unless protected against British and United States competition, and encouraged by way of a government subsidy or bonus on a tonnage basis.

The government were asked to take prompt action to prevent the practical disappearance of the industry in Canada, and the deputation maintained that under existing conditions of competition with Great Britain a government encouragement to the extent of about 20 per cent. of the cost of building iron and steel vessels in Canada should be given either by way of subsidy or by way of tariff protection.

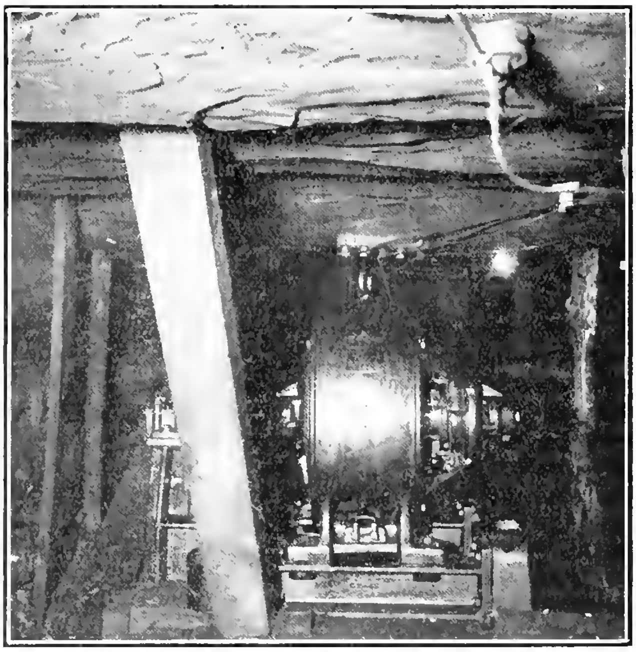
Premier Borden promised careful consideration of the written brief submitted by the deputation, coupled with a suggestion that the government might well adopt a policy of having all government vessels built in Canada, even if the cost was a little more than if the orders were placed in Great Britain.

The English shipbuilding firm of Swan, Hunter and Wigham Richardson are considering entering the Canadian shipbuilding trade, according to the statement of Mr. Clarence I. DeSota, Canadian director of the firm.

SELF-STARTING DIRECT-CURRENT MOTORS FOR DRIVING MINE PUMPS AND FANS.

The electric motor has proved so thoroughly satisfactory for driving mine pumps and fans that it seems almost impossible to improve it. It can be placed wherever a pump or fan can be located; a couple of wires supply it with the power it needs; and when running it requires no attention whatever beyond occasional inspection and oiling. In fact, motors have proved themselves so useful and economical that they are rapidly displacing all other forms of power for fan and pump service wherever electricity is available.

An improvement has, however, been recently developed which greatly increases the value of motors for mine work. This improvement consists in making the direct current motors self-starting.



Heretofore, while it has been possible under some conditions to start them from the power house, most motors driving nine pumps and fans had to be started by hand. Hence, if the power went off temporarily for any reason, the motors stopped, necessitating an attendant to go to each station to start them again.

With the new self-starting D.C. motors, this inconvenience is done away with. When the power fails, the motors stop, it is true, but as soon as the power comes on again, the motors start automatically and settle down to work as though nothing had happened. Moreover, starting boxes are rendered unnecessary, and the wiring is of the simplest possible character. An occasional visit of inspection is now all the motors require. Otherwise they can be left entirely to themselves.

These motors have been thoroughly tried out in practical service and their uses are commending them highly, as is shown by the number of repeat orders the mannfacturers are obtaining.

The electrical characteristics of the self-starting motor differ but little from those of the usual type, the only alteration being in the use of a heavier compounding winding which reduces the flow of current when starting. Mechanically, there is no change.

Self-starting motors are made by the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa., in ratings up to 20 horse-power for the voltage usually employed in mine work. They can be supplied for all kinds of pump and fan service.

COAST TO COAST.

Ottawa, Ont.—Western votes in the main estimates include an appropriation of $10,000 for a new dredging plant for Manitoba, Saskatchewan and Alberta, and $50,000 for improvements to Rainy River.

Boston, Mass.—President Chamberlin, of the Grand Trunk Railway, has raised $6,000,000 to help in the fight of extending the Grand Trunk lines through New England to Boston. The interests opposing this move are large and powerful and will put up a strenuous opposition to the Grand Trunk.

Windsor, Ont.—The Remington Arms Union Metallic Cartridge Company, of New York, have purchased a site for a large plant here and will enter the Canadian field on an extensive scale. No high explosives of any kind will be used and no powder manufactured in Windsor, and ample precautions to guard against possible explosions have been arranged for.

Winnipeg, Man.—Petitions are being circulated to have the duty of 52½ cents per barrel on American cement reduced to 26 cents, so that American cement can be shipped to Canada at a fair profit. This is due to the fact that nearly all the municipalities in the Dominion are looking forward to a banner road-building and construction year, of which cement forms the chief material and Western Canada fears another cement famine unless American cement can be shipped here, but which the present duty prohibits.

Chicago, Ill.—That the Canadian Pacific Railway will have one of its largest terminals in Chicago is indicated by recent purchases of real estate. The Central Terminal Railway, a local corporate name of the Canadian Pacific, has bought three full blocks on the west side. The company has now bought thirteen additional parcels of land near Fifteenth and South Union Streets. The entire property will be used for freight terminals, according to present plans. In addition to down-town land, the company is purchasing property at Harvard Street and West Forty-eighth Avenue for auxiliary yards. To date, the company has bought 252 parcels of land in Chicago at a cost of $2,480,681.

DOMINION SAWMILLS COMPANY REORGANIZED

The receivers, managers and the liquidator of the Dominion Sawmills and Lumber Company, Limited, announce that the following have been appointed as the board of Forest Mills of British Columbia, Limited, successors to the business heretofore carried on by the former corporation:—Messrs. J. M. Savage, of Victoria, chairman; R. S. Lennie, barrister; W. J. Blake Wilson, T. Frank Patterson, all of Vancouver, and W. A. Anstie, of Calgary.

Mr. Anstie will occupy the position of executive agent of the board with headquarters in Vancouver. The receivers express their appreciation of the support accorded them during the period of their management of the business which has now terminated.

The Forest Mills of British Columbia, Limited, owns extensive timber tracts in the interior in proximity to its five sawmills located at Three Valley, Taft, Comaplix, Cascade and Nelson respectively, as well as an organization for selling the output in the local and prairie markets.

The bonds of the Dominion Sawmills, Limited, were practically all sold in Great Britain, and the failure of the company did not help the cause of British capital in Canada.

DOMINION TAR AND CHEMICAL COMPANY.

The timber preserving plant at Sydney of the Dominion Tar and Chemical Company, Limited, is far from being unable to accept orders, but is ready and anxious to treat all classes of timber, railroad ties, bridge timbers, piling, sheathing, etc.

It is not the only plant of its kind in Canada, as the Dominion Tar and Chemical Company, Limited, has a larger plant at Transcona, near Winnipeg, where they have three large treating cylinders operating, creosoting ties and other timbers chiefly for use of the Canadian Pacific Railway. The treating plant at Sydney is an adjunct to a large tar distilling plant of the company which produces in large quantities the creosote oils used in the preservative treatment of timber.

The company has another large tar distillery at Sault Ste. Marie, Ont., engaged in the same operations, except that there is no timber treating plant at that point.

PERSONAL.

JAS. McKEOWN has been appointed superintendent of highways in Welland County, Ont.

E. J. PHILLIPS has been appointed manager of the Berlin, Ont., light and water department to succeed C. T. Wilkinson.

JOHN McKAY, engineer of the trunk sewer, Regina, Sask., has been appointed superintendent of the Regina waterworks.

GEO. ROSS, Associate Member of the Canadian Society of Civil Engineers, has been placed in charge of roadways in Welland County, Ontario.

J. R. WEMLINGER has been re-elected for the second time secretary of the American Society of Engineering Contractors, with headquarters at 11 Broadway, New York.

FRANK H. MARTIN, superintendent of the Toronto Power Company's hydro-electric plant at Niagara Falls, has returned after a six weeks' trip to Bermuda on account of his health.

A. W. ELLSON FAWKES, chief assistant engineer in charge of the mechanical water filtration scheme at Minneapolis, has been appointed waterworks engineer for the city of Calgary.

W. ARMSTRONG, of the Canadian P. J. Mitchell Company, Montreal, will sail for England in about two weeks on business concerning the lines manufactured by Richard Garrett & Sons and Lassen & Hjort.

ALLAN McQUEEN, B.A.Sc., an honor graduate of the School of Practical Science, Toronto University, 1912, has been appointed assistant power engineer of the city light and power system, of Winnipeg, Man.

GEORGE W. FULLER, of New York City, has been retained as consulting engineer to prepare plans and specifications for the 12,000,000-gallon, slow sand filtration plant to be built at Evanston, Ill. Mr. Langdon Pearse will be associated with him on the work.

CANADIAN MINING INSTITUTE.

The annual meeting of the Canadian Mining Institute will be held at the Chateau Laurier, Ottawa, on March 5th, 6th and 7th. The meeting will be opened by H.R.H. the Duke of Connaught. The papers read and discussions will deal with mining industries in the vicinity of Ottawa, including mica and graphite; ore dressing subjects, especially the treatment of the gold ores of the Porcupine district, and the silver ores of the Cobalt district; mining and metallurgy of iron.

ENGINEERS' CLUB OF TORONTO.

The annual meeting of the Engineers' Club was held on the 6th inst., and the annual report for 1912, which showed a very successful year, was discussed. Five new directors were chosen for the coming year: Messrs. Willis Chapman, Hustace G. Bird, E. T. J. Brandon, W. T. Ferrier, and Jas. Milne. The officers for the coming year will be chosen by the directors at the next meeting.

CANADIAN FORESTRY ASSOCIATION.

The annual business meeting of the Canadian Forestry Association was held at Ottawa, February 5th. The election of officers resulted in the choice of Hon. W. A. Charlton, vice-president, as the new president, and W. Power as vice-president. On the board of directors Messrs. J. B. White, E. J. Jarvis, R. D. Pretty, H. R. MacMillan, of British Columbia, and G. Colquhoun were added to the list. The secretary, Mr. James Lawler, was re-elected.

COMING MEETINGS.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urhana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb 26th to Mar. 8th.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March, 3, 4 and 5, 1913, in the Green Room, Congress Hotel and Annex, Chicago Ill. Secretary, Will P. Blair.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W. Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St., Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Bravley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P. O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chas. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Feb. 20, 1913 Contents of this issue on page 33

The Canadian Engineer

An Engineering Weekly

NOTES ON HEADGEARS FOR COLLIERIES AND OTHER MINES.

By F. TISSINGTON.

The headgear or frame supporting the pulleys around which pass the ropes attached to the cages for the conveyance of men and material to and from the working level is generally the most important structure in any mining equipment, as on its utility and stability depends the entire output of the mine as well as the safety of the men working underground.

Under these circumstances, therefore, it will be readily seen that it is not a wise policy to attempt to skimp the material, design of details, or execution of the work in the shop, but, in view of the indeterminate nature of the vibratory stresses on the structure and the sudden application of loads, good allowances should be made for impact and low unit stresses adopted generally.

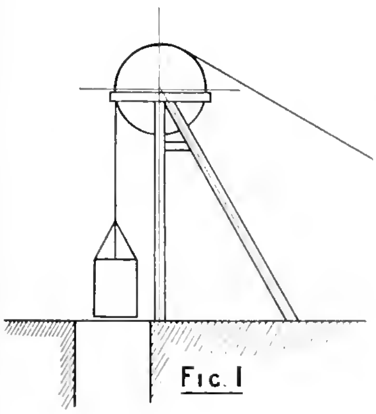


Fig. 1

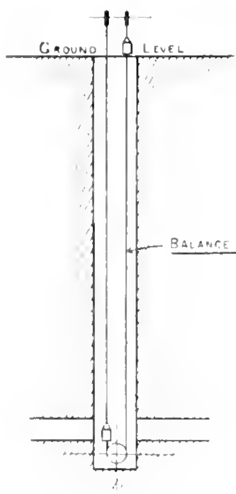


Fig. 2

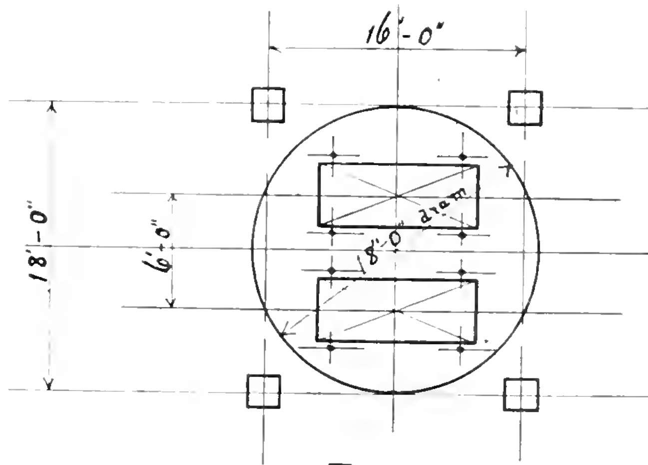


Fig. 3

Quite a large amount of the detail work is purely derived from experience and practical requirements, and this will be referred to in detail later.

Probably the earliest form of headgear consisted of a timber frame built up in the manner shown in Fig. 1. The writer has seen quite a number of this type, ranging from about fifteen to thirty feet high, with more or less detail, according to the loads carried. Generally, however, the speed of winding was very slow and the loads light; also, each frame carried one pulley only, so there was no necessity for much equipment in the way of guides.

As the seams near the surface were worked out and the demand for coal grew, a gradual evolution took place in all colliery equipment.

With the increased depth and greater time occupied in winding the material to the surface, the desire to carry more coal per trip arose, and consequently we see to-day collieries with winding plants capable of handling three and four loaded tubs per trip and landing same at the pit mouth from the working level, which may be anything up to about three parts of a mile, well under a minute.

Double, and even treble, decked cages are to-day quite an ordinary event, and occasionally you will find a plant where two pit tubs or corves are carried on each deck, each containing about 1,600 or 2,000 pounds of coal, and, with the cage, chains and rope, making in all somewhere around 30,000 to 40,000 pounds of dead weight to move on the loaded side of the shaft.

Practically all modern plants are designed with two sheaves or pulleys on the headgear, each provided with a rope supporting a cage, arranged so that when one is at the top of the shaft the other is at the bottom, and thus to a large extent they balance each other, so far as the winding engine is concerned, as the two ropes are led to two drums, mounted side by side on the same shaft, one being taken over the top side of the drum on the one side, and the other led underneath the other drum, so that as soon as one rope unwinds the other winds up.

The amount of the unbalanced load is measured by the quantity of coal carried per trip and the difference in the length of the rope from the supporting pulley on the headgear to the cage.

Sometimes, however, the latter is also balanced, and this is done by attaching another rope to the bottom of each cage and passing same around a pulley in the bottom of the shaft exactly as shown in Fig. 2.

With the operation of two cages in one shaft came the necessity for the addition of guides to prevent the cages swaying about at the end of the ropes and clashing together as they passed each other.

These guides are of two general types. (1) The timber, or rail guide, which is fastened to cross pieces, called "buntons," let into the wall of the shaft at intervals to suit. These are not supported by the headgear, and, therefore, do not concern us.

(2) The other type is the guide-rope. Generally a set of these for each cage consists of four ropes, but for the larger cages six or more may be used. These are suspended directly from the headgear frame at a point just below the pulley platform. To the lower end of these ropes are attached cast iron weights in order to keep them taut and hanging vertically. Sometimes as much as ten or twelve tons will be suspended at the end of each rope, and, with the weight of the rope itself, these guides form quite a formidable load to design for. The guide-ropes, like the

Where P = effective pull in pounds causing motion.
T = Tension on the rope in pounds.
A = Acceleration of load in feet per second in a second.
W = Weight of cargo, load, and rope in pounds.
G = 32.

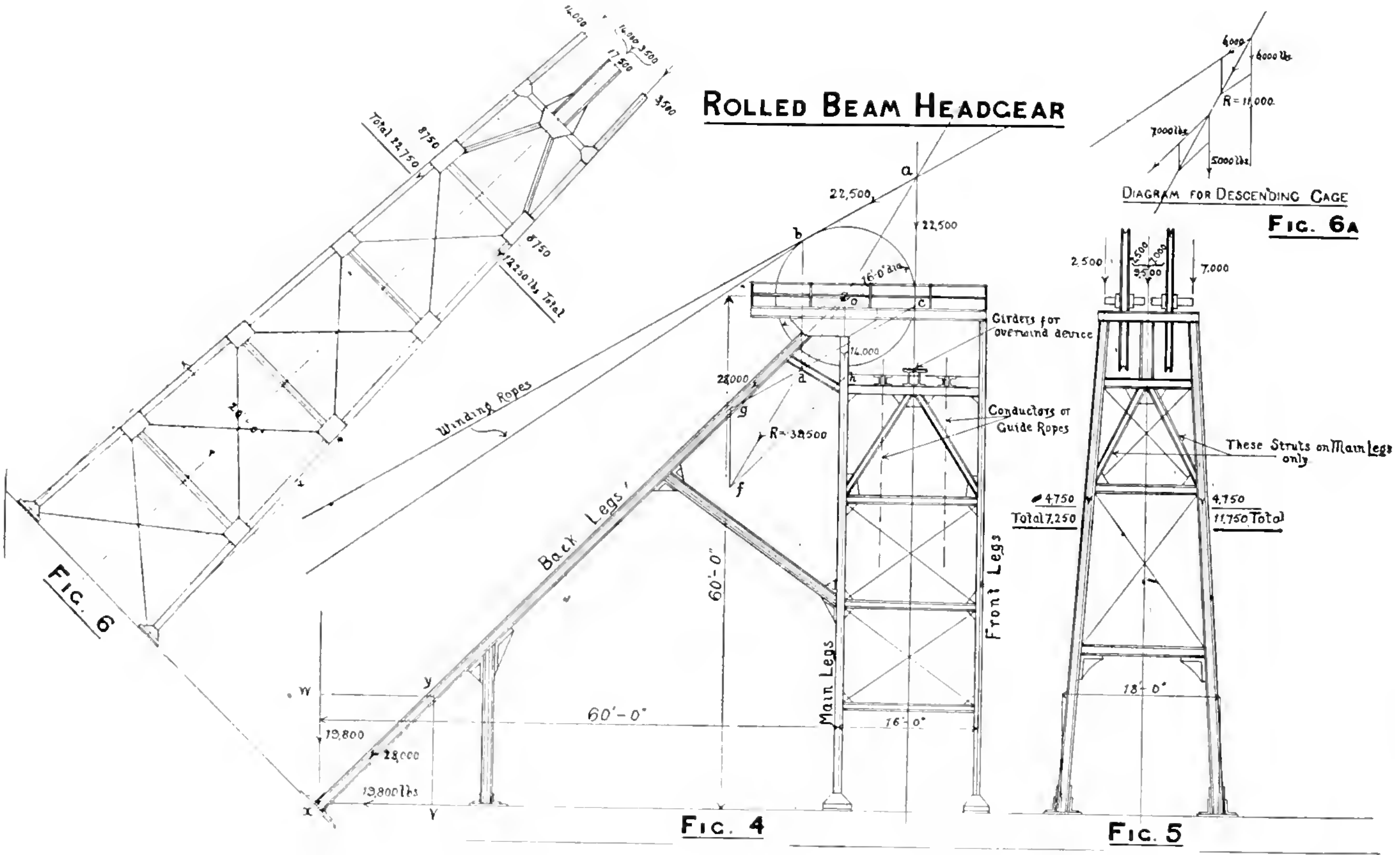
$$\text{Now } P = T - W,$$

$$\text{and also } P = \frac{WA}{G};$$

$$\text{therefore } T - W = \frac{WA}{32},$$

$$\text{or } T = W\left(1 + \frac{A}{32}\right)$$

It will be seen from this formula that if we take unit weight, then when the acceleration reaches, say, 32 feet per second, the tension in the rope will be twice that for load at rest.



winding ropes, are all made of steel, and the diameter will be anything from one inch to an inch and a half.

With all winding or hoisting engines there is an increase in stress on the hoisting rope, due to the acceleration of the load, and this may amount to half the dead load suspended from the rope.

It has also been demonstrated that quite a large increase in stress is due to the vibration of the cage, caused by the pulsation of the engines, and this is very similar in effect to a piece of elastic held in the hand with a weight suspended at the free end, when a slight movement of the hand will cause the weight to jump about for a considerable period after the cause is removed. These pulsations are much more noticeable with engines of an inferior type, and also with the sudden application of the brakes or checking the speed by shutting the steam valve quickly. With an increase in load the vibrations appear to become less.

The increased stress on the rope due to acceleration may be found by the following method:—

Therefore, knowing the acceleration of the cage and load, and also the total weight to be lifted, the tension in the rope will always be W plus some fraction of W represented by $\frac{A}{32}$. For usual practice this is generally in the neighborhood of one and a half times the load, or the acceleration is approximately sixteen feet per second in a second.

Other loads of an important character are those caused by over-winding, when a safety catch is provided for supporting the cage after the rope has been automatically released, and also the adoption of a safety catch if the rope breaks.

To the tyro it looks a most difficult operation to bring a heavy engine and its load to rest at exactly the right place every time, year in and year out, but with the appliances and safety gear used to-day it really resolves itself into a purely mechanical operation. However, mistakes are

sometimes made, even with the best of men, and the winding engineman is as careful and painstaking as his brother of the railway engine.

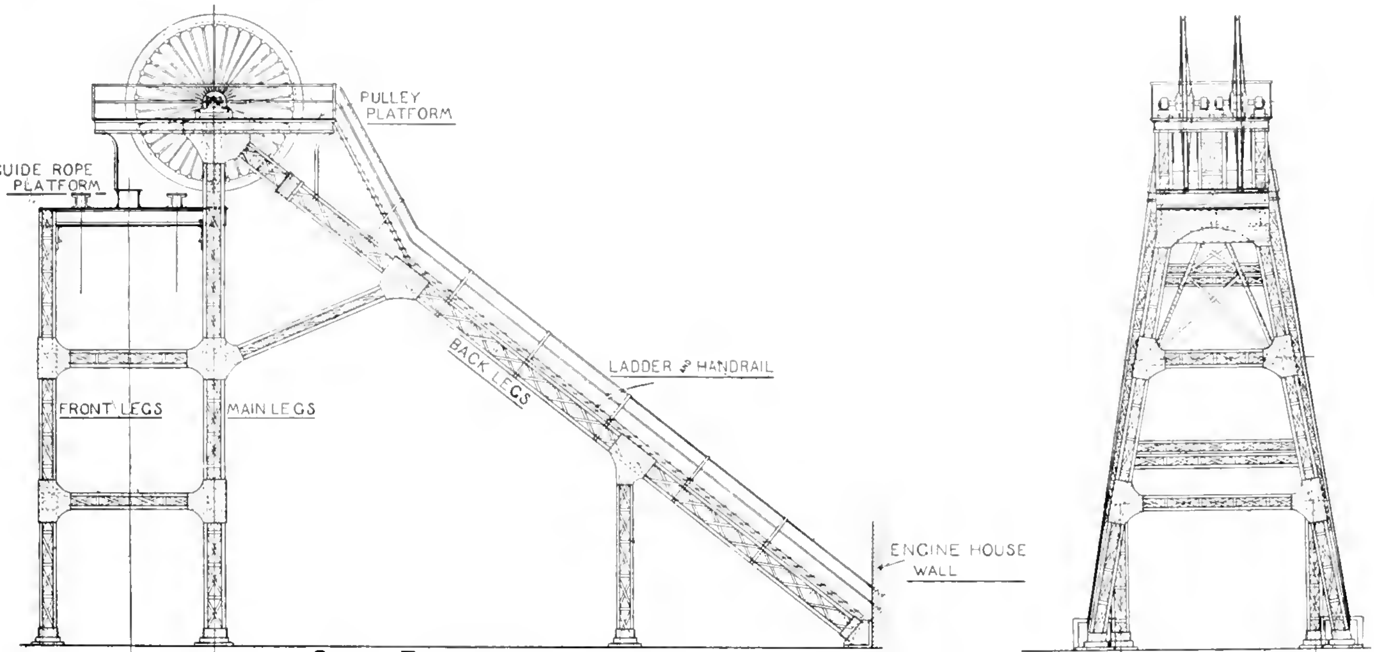
In the early days it occasionally happened that the engineman forgot to shut off his steam soon enough or omitted to apply his brakes in time, and, instead of landing his load either of men or material at the appointed place, brought the cage right over the pulley, or, failing that, broke the rope at the top of the headgear and dropped the cage to the bottom. In order to prevent this the King's safety hook was designed. This is operated by means of a heavy plate having a circular hole cut in same through which the rope passes normally, and is usually placed on the guide-rope platform. In case of an over-wind the catch, or safety hook, passes through the plate until the sides come into contact with same. This causes the rope to be released at the top, and also spreads out the part of the hook above the plate, at the same time providing a lug or catch on the safety hook which matches with the plate, and so prevents the cage from falling down the shaft again. This operation causes quite a severe shock to the headgear, as the cage and its contents would actually drop a few

(1) The rolled steel headgear made with I-beams, channels, etc., and braced with angles and tie-rods; and

(2) The lattice headgear, in which practically the whole of the members are composed of four angles, placed to make a box section, and laced together on all four sides with small flats.

Each type possesses particular advantages. That made from rolled I-beams, etc., is easier and cheaper to produce, although the dead weight to handle will generally be greater. The facility with which the connections can be made and the use of standard details to a large extent make it rather desirable from a shop and erecting point of view, but it has one great disadvantage, and that is the lack of stiffness without the insertion of a large excess of weight, which would put it right out of the running. With the advent of the broad flange beams, however, during the last few years this has been improved to quite a large extent.

The greatest detriment to the lattice headgear is the high cost per ton produced, which, however, is offset to a large extent by the decrease in weight necessary to carry a given load, as the disposition of the material more nearly



SIDE ELEVATION FIG. No. 7 FRONT ELEVATION

LATTICE TYPE HEADGEAR

inches, and, therefore, it is necessary in cases where this gear is adopted to allow for this extra load.

The other device, used in cases where the winding rope breaks, produces a stress on the guides, as generally it is of the slipper type, actuated by a spring, and only comes into operation by the rope parting.

The stress in this case also is liable to be very severe, as the rope may break at the maximum speed, and a small fraction of time must elapse before the various parts fulfil their duty, and during that time the cage is increasing its velocity. The action is purely of the character of a brake, and it would be fairly good practice to allow about twice the dead load of the falling cage, chains, rope and load for both cases, and also use a low unit stress on the parts affected.

In addition to the special loads described, the structure will have to be designed to carry its own dead weight, wind and snow loads. The two latter loads, however, are not of a very serious nature as compared with the live loads.

There are two types of steel headgear in general use:—

approaches the ideal form for struts and columns. Other features which prohibit its adoption in many cases are:—

(1) The increased area of metal exposed to the action of the weather, and consequently greater danger of oxidation of the structure.

(2) Painting is also more costly, not only on account of the greater area to cover, but also for the comparative inaccessibility of the various parts.

For a given amount of material there is no doubt but that the lattice structure provides a high degree of stability and freedom from vibration. Taking it all round, there appears to be very little ultimate difference in the two methods, and generally the type is chosen according to the fancy of the purchaser, or settled by the manufacturer to suit his outfit and stock material.

Figs. 4, 5 and 6 show the general outline of a rolled beam headgear, and Fig. 7 is a type drawing of a lattice structure, and from these figures a good idea may be obtained of the usual disposition of the material.

It is now proposed to give the general method of arriving at the total stress on the main members, and we will assume the following figures to form the basis of our calculations:—

	Pounds.
Weight of one cage, empty	4,000
Weight of two tubs, empty	1,000
Weight of rope	7,000
Total descending cage	12,000
Weight of coal per trip	3,000
Total ascending cage	15,000

Acceleration = 16 feet per second in a second.

Therefore, stress or pull on descending rope = 6,000 pounds.

And stress on ascending rope = 22,500 pounds.

Weight of eight guide or conductor ropes and weights = 96 tons.

Height of headgear = 60 feet to centre of pulley.

centre line of shaft, thus making an oblong of eighteen by sixteen feet.

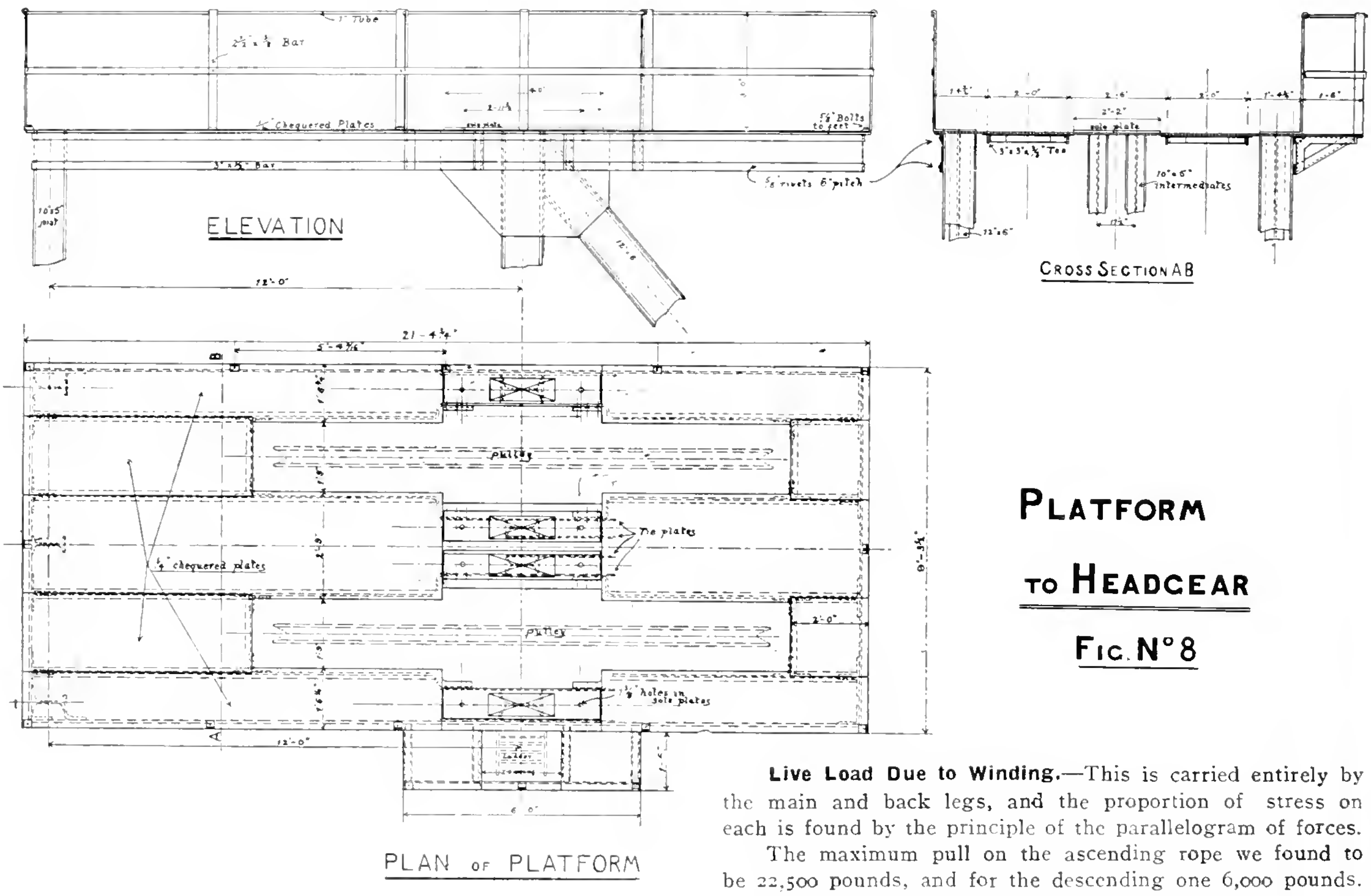
The position of the back legs is generally determined by the wall of the engine-house, which takes up any horizontal thrust there is. Should this support not be available for any reason, separate foundations must be made to carry the loads safely.

Referring now to Figs. 4, 5 and 6, these give the outline of the structure in side and front elevations and a true view of the back legs, respectively.

The short diagonal struts (or spurs, as they are sometimes called), shown in Fig. 4 below the girder for the over-wind gear on the guide-rope platform, are for the purpose of transferring the load from the over-wind girder directly to the main and front legs, leaving only the quiescent load on the conductors to be carried in bending.

The similar struts in the other two views also transfer the loads from the inside bearings of the two pulley shafts direct to the main and back legs without introducing transverse stress.

Having settled the general layout, we will now proceed to find the stresses on the main members.



PLATFORM TO HEADGEAR

FIG. No 8

Diameter of shaft = 18 feet.

In starting to set out our frame the first consideration should be to plant the legs of our structure where they will get a good, solid foundation, and also to give a diameter of pulley for the rope suitable for its size. We will, therefore, assume that it is necessary to have pulleys 16 feet diameter in order that the bending stresses do not run too high. (This information is usually supplied by purchaser.)

If this dimension is plotted down in plan, as shown in Fig. 3, it will be easy to arrive at a suitable figure for the other dimension tying up the position of the four legs round the shaft, so that the bases do not come too close to the edge of same, and it will be noted on referring to the figure that they are placed at nine feet each side of the

Live Load Due to Winding.—This is carried entirely by the main and back legs, and the proportion of stress on each is found by the principle of the parallelogram of forces.

The maximum pull on the ascending rope we found to be 22,500 pounds, and for the descending one 6,000 pounds.

Referring to Fig. 4, and treating the ascending load first, if the lines indicating the rope on both sides of the pulley are produced until they meet, which will be at the point "a," and from this intersection lengths are scaled along both lines to represent the maximum tension in the ropes, as shown by "a b" and "a c," then by completing the parallelogram "a b d c" the resultant of these two forces can be found, namely, "a d," and on being measured by the same scale the magnitude of this resultant is approximately 39,500 pounds. This line, it will be noted, passes through the centre of the shaft, and indicates the desirability of using angular bearings rather than the ordinary vertical type. This resultant can now be resolved into two other components acting in the direction of the main and back legs, respectively.

Starting from the centre of the pulley shaft (which is always made the intersection point of the main and back legs) marked "o," measure along the line "o d" produced the length "o f," which represents by any suitable scale the magnitude of the resultant, viz., 39,500 pounds, and then from the point "f" draw parallel lines with the main and back legs, and the intersection of these lines with the centre lines of the two legs will complete the parallelogram "o g f h," and by the same scale with which the resultant was plotted down the magnitude of the stresses on the two legs are found to be 14,000 pounds for the main and 28,000 pounds for the back legs.

For the descending load the small diagram (Fig. 6a) gives the corresponding figures, and, referring to Figs. 5 and 6, the distribution of these stresses on the two main and two back legs will be seen, and are self-explanatory.

Guide Ropes and Weights.—There are eight of these, four to each cage, and each will weigh twelve tons, complete. Each of the main and front legs will support one-fourth of the total load, viz., 24 tons.

Stress Due to Overwind.—The maximum will be equal to the weight of the cage, tubs and coal, multiplied by two to allow for impact, which will in this case amount to 8,000 × 2 = 16,000 pounds.

Referring to Fig. 4, it will be seen that this load is supported by a heavy cross girder, and the exact distribution will depend on the relative distances between the point of application of the force and the points of support at each end of the girder.

Without having anything more definite we will assume that two-thirds of the load will be carried to one end as a maximum, and this will be equally distributed between one front and one main leg by the action of the spurs or struts referred to previously.

As it will be impossible to get the stress due to winding and over-wind at the same time, it will only be necessary to take the greater of the two, so far as the main legs are concerned, but for the front legs this will be an additional load to allow for.

For the case of the winding rope breaking in the shaft, the distribution of the stresses caused will be practically identical with the above, and the allowance made for the over-wind will answer for this also.

Dead Load of Structure.—This is generally assumed from data obtained in previous cases. For this particular case it may be taken at fifty tons. Approximately twelve tons of this will be carried by the two back legs and the remainder about equally on the main and front legs, namely, nine and a half tons each.

Wind Load.—A maximum of about 30 pounds per square foot of actual area of frame exposed will be quite good practice. As, however, it is rather difficult to obtain this information until the calculations are completed, an assumption may be made that the area exposed equals about one-fifth the total area enclosed by the outside lines of the frame.

By adopting this latter course we find the total area is about 2,800 sup. feet, giving a total wind load of 16,800 pounds.

The centre of gravity of this force will be about halfway between the ground level and centre of pulley shaft, and, therefore, the moment will be

$$16{,}800 \times 30 = 504{,}000 \text{ foot pounds.}$$

This will be divided about equally between the three pairs of back, main and front legs, and, therefore, the maximum stress on any leg will be equal to:—

$$\frac{504{,}000}{3 \times 18} = \pm\ 9{,}333 \text{ pounds, according to the direction of the wind.}$$

Where 18 feet = the centre of the legs at the base in ...

Neglecting snow load, which will be comparatively small for a structure of this class, and tabulating the figures found, we have the following:

Table of Stresses on Front, Main and Back Legs of Headgear.

Nature of stress.	Front legs.	Main legs.	Back legs.
Dead loads—			
Guide-ropes and weights..	48,000	48,000	....
Weight of structure	19,000	19,000	12,000
Total dead load	67,000	67,000	12,000
Live loads—			
Winding stress	....	14,000	28,000
Over-wind stress	2,700	2,700	...
Wind load	9,500	9,500	9,500
Maximum live load	12,200	26,200	37,500
Add 100 per cent. to live..	12,200	26,200	37,500
Grand total	91,400	119,400	87,000

The ordinary methods are now adopted for finding the sections, and a suitable formula would be:—

Permissible safe stress in pounds per square inch =

$$18{,}000 - 70\frac{L}{r}$$

Where L = length in inches between supports,
and r = least radius of gyration of section.

Pulley Platform.—Fig. 8 shows a general plan of a platform from which the construction can be clearly seen. The girders supporting the floor plates are made from angles and web plates. Sometimes, however, and where the details will permit of same, it is cheaper to use channels in place of these built-up girders. Usually, heavy steel plates, half to three-quarters of an inch thick, are laid under the cast-iron sole-plate of the pedestal with the idea of distributing the load as evenly as possible over the intersection of the main and back legs. The floor-plate should preferably be of chequer plate, and if these are judiciously arranged, quite a large amount of stiffness is imparted to the top of the structure to resist the torsional strains due to the unbalanced stresses on the two winding ropes.

Guide-rope Platform.—The construction of this would be similar to the above, and the conductor and over-wind girders would form the supports for the platform.

Practically speaking, neither platform has to support any vertical load other than that of a man walking around or any loads due to repair work going on, and the latter is not likely to be very excessive.

The design of these platforms is largely one of practical experience, and perhaps their most important function is that of a diaphragm, as suggested previously.

The pulley platform may be supported either as shown in Fig. 4 on all six legs, or as indicated in Fig. 7 on the main and back legs only, with the small angle struts inserted as steadiers.

The girders for the guide-ropes and over-wind gear are calculated for in the usual way, the only point to watch being an adequate allowance for the sudden dropping of the cage and its contents on same.

Bracings, Struts and Diagonals.—The whole of these members are put in solely for the purpose of stiffening the structure and reducing the unsupported lengths of the legs.

Generally, the working out of the details will determine to a large extent the best sections to use, and this feature, combined with the general principles of symmetry and proportion and usual practice, will bring about a result which is at once reliable and pleasing to the eye.

RESURFACING OF A TARVIA ROAD IN ST. THOMAS, ONT.

By M. H. Baker, City Engineer, St. Thomas.

In 1912 a portion of Gladstone Avenue, to the extent of 1,681 yards, was re-surfaced with Tarvia X. The portion of the street in question was one of the first macadamized streets laid in St. Thomas, having been constructed in 1894 by Mr. R. W. Campbell, then city engineer. The street provided ample material for the construction of the Tarvia pavement, with the exception of two cars of fine stone which were required for surfacing.

The Tarvia was heated in kettles and applied in the form of a spray by a small tank wagon, provided by the Paterson Manufacturing Company, steam pressure being supplied to the tank by the steam roller. This method is rather costly; the more economical method being to have the material supplied in tank cars and heated by steam.

The surface of the roadway was first swept as clean as possible with hand brooms, then spiked with the steam roller. After the roadbed was thoroughly broken up, it was found to be too dirty to apply the Tarvia, so, all the stone was screened, to remove all dust, loam and fine material. It may be of interest to note that the screenings were found to be of the following composition:—

Moisture	6%
Gravel and coarse sand	58%
Fine sand	15%
Clay and organic matter	21%

The screened stone was then graded and rolled to within two inches of the surface of the completed roadway. This surface was then given an application of Tarvia, and 1½-inch stone filled over this and rolled to approximately the surface of the completed road, and Tarvia again applied. Over this was spread stone chips to cover the Tarvia, and another application of Tarvia lightly sprayed over this. This was all covered with a coat of sand and thoroughly rolled to a smooth, hard surface. After a couple of weeks' traffic had worked the sand into the surface, the street was swept clean, and presented a smooth, hard surface.

The cost of the work was as follows:—

Tarvia	$ 408.50
Freight and cartage on Tarvia, kettles and tank wagon	111.98
Roller (a charge of $10 per day was made on the street)	105.00
Crushed stone	82.29
Miscellaneous (tools, etc.)	13.79
Labor	364.19
Sand	4.00
	$1,089.75

This makes a cost per yard of $.648.

THE SUDBURY NICKEL FIELD.

An important purchase has been negotiated in the Sudbury nickel field during the last two weeks, and is noted in the Engineering and Mining Journal. Dr. F. S. Pearson, who has been closely identified with Sir William MacKenzie in his hydro-electric power enterprises in Canada and Mexico, has taken over the holdings of the Dominion Nickel-Copper Company. It is believed, however, that Doctor Pearson and his former associates will not be called upon to do the financing, rumor having it that the money will be put up by the Rothchilds.

BRICK PAVEMENT FOUNDATIONS.

In commenting on the relative economy of using a sand or concrete foundation under a brick pavement the chief items to consider are first cost, maintenance and life. In the following discussion of the three items of first cost, maintenance and life the experience of the Department of Public Service of the City of Cleveland was described before the American Association for the Advancement of Science by Mr. Robert Hoffman, chief engineer of the Department of Public Service.

The city of Cleveland first began to lay brick pavements in 1889 and has continued doing so ever since, until at present there are about 328 miles of streets paved with brick, subdivided as follows:

257.61 miles, 5-in. brick, sand foundation.
19.39 miles, 5-in. brick, concrete foundation.
39.17 miles, 4-in. brick, concrete foundation.
11.84 miles, 4-in. brick, sand foundation.

Since then prices paid for brick pavements have varied from $1.18 per square yard to $2.48, depending on the various forms of foundation and size of brick used.

The following table indicating the various paving combinations employed in Cleveland for brick pavements shows the yearly average maximum and minimum prices paid per square yard since the year 1900. The cost of excavation assumed at 50 cents per cubic yard is included as measured below the top of the paving brick.

Cost of Brick Pavement Per Square Yard Since 1900.

Size of Brick.	Foundation.	Minimum.	Maximum.
5 in.	Natural sand	$1.18	$1.56
5 in.	8-in. sand or gravel	1.40	1.97
5 in.	6-in. concrete	1.94	2.48
4 in.	6-in. concrete	1.71	2.34
4 in.	4-in. concrete	1.47	1.73

Investigation has shown that the prices paid for the various combinations seem to rise and fall in the same years, which would indicate that the variations depended upon the material and labor market and not on the difference in combination.

The earlier of the brick pavements consisted of small blocks of fireclay 4 in. in depth, laid upon a natural sand foundation. Some of these are still in use though in service on residence streets for 20 years. In other localities, partly on account of traffic conditions, brick pavements on sand foundations required relaying in less than 15 years.

No pavements of brick laid according to recent specifications and practice, nor any laid on concrete foundations, have been in existence long enough to cause any thought of re-laying.

In reference to the brick pavements that now require relaying having reached a condition where any adequate repair would prove far too expensive, it could probably be shown that other defects, such as improper filler, poor brick, or defective construction, had as great an influence in causing deterioration as did the sand foundation. An entirely different condition would probably be found in an open and poorly drained clay district.

In considering the relative economy of sand and concrete foundations for brick pavements experience will show that a properly laid pavement of 5-in. brick on a sand foundation will have a life of at least 15 years, if laid in residence or light business traffic streets. A 4-in. brick under similar conditions would probably have a life of three or four years less.

The problem is to compare the cost of such a pavement with one laid on a concrete foundation the actual life of which has not yet been determined by experience.

The following prices are the average for the last three years and therefore expressive of existing conditions:

5-in. brick, natural sand foundation, $1.27 per sq. yd.
5-in. brick, 8-in. sand or gravel found., $1.58 per sq. yd.
4-in. brick, 4-in. concrete foundation, $1.60 per sq. yd.

Assuming a 15-year life for the 5-in. brick pavement on a natural sand foundation, and the interest to be paid as 4 per cent., it will require a payment of 9 per cent. per year to pay interest on the cost of paving and to provide a fund for its renewal at the end of 15 years. This means an annual payment of 9 per cent. of $1.27 or $0.1143.

In order to compare this with the case of a 4-in. brick pavement laid upon 4 in. of concrete, the same annual payment of $0.1143 must be assumed. Deducting 4 per cent. of $1.60, the cost of such a pavement, for the interest charge, or $0.064, leaves $0.0503 to be applied per year for amortization. This amounts to a little over 3 per cent., and according to amortization tables would require a period of 22 years to provide the renewal fund.

In other words, the pavement upon the concrete must have a life of 22 years in order to be as cheap as the one upon the natural sand having a life of 15 years.

Comparing the cost of the 5-in. brick upon a ballast of 8 in. of sand or gravel with the brick upon 4 in. of concrete, it is readily seen that the difference is so small that both could have the same life at the same cost per year. Evidently then, the concrete foundation is as cheap as the other, and much more economical, as the probability of longer life is much greater.

A 4-in. brick laid upon a natural sand foundation would cost about $1.07 per square yard, using the same cost data as used for the 5-in. brick. If such a pavement had a life of 12 years, with money at 4 per cent., it would require an annual payment of about 11 per cent., or $0.1177.

Comparing this with 4-in. brick on 4 in. of concrete, one sees that the latter would be equally cheap per year if the life of the pavement were about 21 years. It can likewise be shown that the 5-in. brick would be as cheap as the 4-in. if the life of the former were 3 years longer.

Similar calculations will show that a 4-in. brick laid on 6 in. of concrete will be as cheap as 4 or 5-in. brick on the 8-in. sand ballast if its life is 18 years.

From this method of reasoning it may be concluded that where a natural sandy foundation under good conditions is found it will probably be as economical to lay a brick pavement without a concrete foundation as with one, and the first cost will be considerably less. In other locations, however, where it is necessary to bring upon the work from elsewhere the sand or gravel ballast, the first cost will be nearly as great, and the pavement with the concrete foundation will ultimately prove to be the more economical of the two investments.

Several other matters must, moreover, be given consideration when passing judgment on the question. In Ohio, for instance, the municipality though paying only a relatively small proportion of the cost of the initial pavement, namely, the part laid in street intersections and 2 per cent. of the remaining part, must pay 50 per cent. of the expense of relaying any pavement. It is, therefore, decidedly to the advantage of the municipality that a pavement should be so laid that its life will be as long as possible, so that the repairing expense shall come only at long intervals.

An unyielding sub-base, such as concrete affords, is highly desirable, and should be supplied wherever possible, and in most cases will prove more satisfactory even at slightly greater cost. Concrete will carry the pavement load over the many soft places caused by street openings prior to paving and will prove a greater factor of safety against settlements and irregularities liable to occur where no concrete is employed. Any settlement in a pavement foundation breaks the bond of the brick and will be rapidly followed by serious deterioration.

Another possible economy in supplying a concrete foundation may be found in the possibility that some time it may be desired to replace brick with other kinds of paving material for which a concrete foundation must be supplied, such as wood block, asphalt or asphaltic concrete, in which event the cost will be materially lessened by reason of the existing concrete.

In open country, with poor drainage facilities, there is no doubt that the damaging effect of frost and the yielding subsoil would soon depreciate any brick pavement with only a natural soil foundation, and under such conditions concrete is the only safe and economical foundation to use.

RAILWAY TERMINALS.

The subject of railway terminals is one that comes up constantly, with its increasing complexity due to the rapid growth of traffic on Canadian railways. Passenger terminals are of more immediate interest to the general public than freight terminals, and have therefore received much more attention. Yet the freight traffic on most American railways yields the greater part of the gross revenue, and arguments for greater attention to it are set forth in a paper by Mr. L. C. Fritch, chief engineer of the Chicago Great Western Railroad, presented January 14, before the Canadian Railway Club at Montreal. These notes are taken from the paper.

The cost complete of the New Grand Central Terminal in New York City will probably be $200,000,000, a sum that would build 2,000 miles of double track road at $100,000 per mile. This terminal will serve but two railroads, the New York, Central & Hudson River and the New York, New Haven & Hartford. The new Pennsylvania terminal in the same city, serving only the Pennsylvania and the Long Island Railroads, is estimated to have cost to December 31, 1910, $113,000,000. In each case the annual fixed charges, taxes and depreciation, figured at 10 per cent. of the initial cost, plus a much smaller sum for operation and maintenance, will amount to nearly half the annual gross passenger receipts at these terminals of the railroads concerned.

Similar figures may be presented for the Chicago & North Western passenger terminal in Chicago and for the terminal under construction at Kansas City, Mo. Some of the roads which will use the latter terminal will pay more for the privilege than their entire passenger receipts derived from Kansas City. The combined value of passenger terminals used by he Pennsylvania in New York, Philadelphia, Baltimore and Washington is $178,000,000. This is an average of about $800,000 per mile of road from New York to Washington, and the fixed charges alone will average $40,000 per mile.

The annual passenger revenue on all railways in the United States is about $750,000,000. The freight revenue is about $2,000,000,000, or nearly three times as much. Yet so much attention has been given to passenger terminals that only limited appropriations have been made for freight terminals, and their possibilities in the way of economies have been developed to a limited extent only. Existing facilities are in many localities grossly inadequate to handle the rapidly growing traffic with the necessary promptness, and there must be almost a revolution in such cities as Chicago in the methods so long in vogue.

PLANT INSTALLED AT THE LONDON PAPER MILLS AT DARTFORD, ENGLAND.

The plant consists of:—

1. Receiving hopper with supports placed outside the boiler-house on the bank of the river, in such a position that the coal can be deposited into the hopper by a crane and grab.

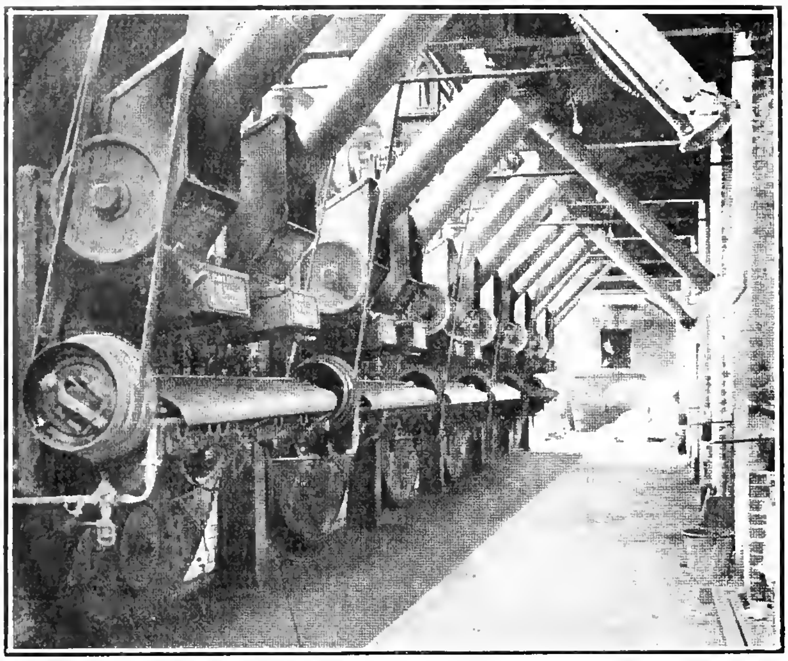


Fig. I.

A range of "Bennis" High Temperature Machine Coking Stokers keeping steam in the boiler-house of the London Paper Mills.

2. Overhead coal storage bunker having a capacity of about 330 tons of coal.

3. Bennis U-link chain conveyors with driving gear and all supports.

4. Shoots to carry the fuel from the bunkers to the hoppers of the Bennis mechanical coking stokers by which the boilers are fired.

The method of operating the plant is as follows:—The coal is brought up to the wharf in barges. A grab load of coal is raised from the barge by the crane, and dumped into the receiving hopper from which it flows through an outlet into the chain conveyor, which is placed immediately beneath. The first portion of this chain conveyor is carried up an incline and the coal is thus raised to the level of the top of the bunkers. The conveyor then passes horizontally over the top of the bunkers, and the coal is dropped through openings into the storage bunkers beneath.

The coal flows by gravity from the storage bunkers into the storage hopper, and a valve is placed at the end of each shoot to control the supply of coal.

The conveyor is of the well-known U-link chain type. It has a capacity of 40 tons per hour, and is driven through suitable reduction gear by a separate motor. The overhead coal storage bunkers are built over the firing floor and are about 80'-0" long x 11'-0" wide having a total capacity of about 330 tons. The boiler-house wall is utilized for one side of the bunkers, the other side consists of a reinforced brickwork wall. The bottoms of the bunkers are hoppered in shape, and are formed out of rolled steel plates with suitable stiffeners and connections.

A number of rolled steel joists run the whole length of the bunker to form supports and carry the weight between the stanchions. These longitudinal joists are supported in their turn by other transverse joists spanning the firing floor and carried at one end on substantial stanchions, resting on the floor, the other end being built into the wall of the boiler-house. These stanchions are also used for supporting one side of the main boiler-house roof, and a light roof is built over the top of the bunkers themselves.

Access is given to the conveyor chamber over the bunkers by ladders and gangways, arranged so that all running parts are easy of access for inspection and lubrication.

The bunker was designed to take full advantage of the existing buildings and to give the required storage without forming any obstruction to the movements of the boiler attendant. It is so arranged that future extensions can be easily effected.

The work of the U-link chain conveyors is to feed the coal to the bunkers which deliver it by means of openings into the distributing shoots which deposit it in the "Bennis" high temperature smokeless and gritless coking stokers. The illustration affords a good view of this range of stokers with the shoots in position and in close connection with the bunkers immediately above.

It is, of course, important that steam-raising in paper mills should be smokeless and gritless. Harm will be done to both paper and pulp in various stages of their manufacture should grits and smuts be emitted from the chimney and so find their way into the incomplete manufactures.

The plant was designed and installed by Edward Bennis and Company, Limited, who are represented in Canada by Geo. H. Tod, of Toronto.

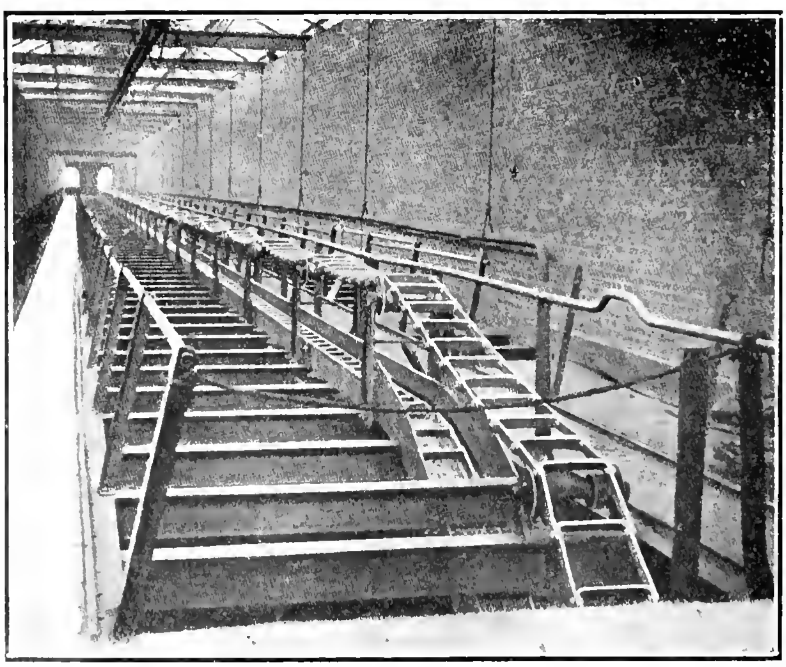


Fig. II.

"Bennis" U-link Chain Conveyor which in part of its travel is inclined to carry the coal to the level of the top of the bunkers. It deposits its contents by means of openings into the storage bunkers beneath. It forms part of the "Bennis" installation of coal handling plant in the boiler-house of the London Paper Mills.

REINFORCED CONCRETE IN CHURCHES.

By V. J. Elmont, C.E., A.M.Can.Soc.C.E.

The essential requirements that one must meet in designing churches and similar buildings are that they should be absolute fireproof and have proper acoustic quali-

Fig. 1.

ties; these requirements are best met by reinforced concrete. In respect of this latter it is interesting to note that organs have actually been built of reinforced concrete in the United States.

Its ability to resist fire has been tested over and over again. Numerous fires in actual buildings have shown that concrete is practically impervious to fire. Also the various technical laboratories have proved how slowly heat penetrates concrete and the fitness of reinforced concrete structures to resist high temperatures. The worst that the ordinarily severe fire will do is to cause a crumbling of concrete on surfaces exposed to the heat, rarely to a depth of more than one inch. Both on this and on the other side of the ocean a great number of test buildings have been constructed entirely in reinforced concrete in order to determine the varying importance of the intensity and duration of the heat applied, its method of application, and the thickness of protective covering.

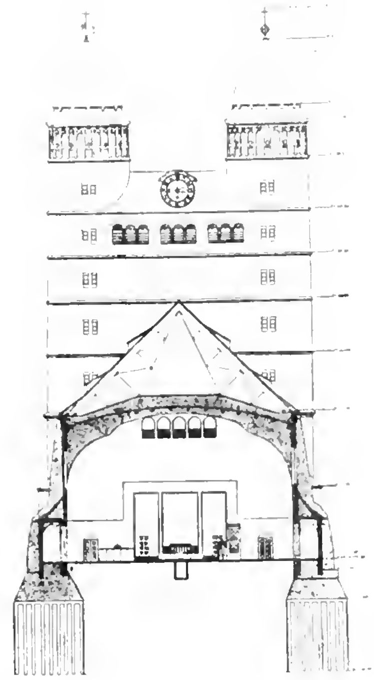


Fig. 3.

As seen from an engineer's point of view, reinforced concrete solves in the easiest and most economical way the difficult problems of construction that constantly occur in the class of buildings we are considering. Reinforced concrete renders it possible also for the architect to design with a free hand and only to take the artistic requirements into consideration. Where steel is used many complications arise through the use of complex construction and also much time is lost and cost entailed in carrying out such work, not to mention the expenses for the covering of such steel with a fireproof material.

The elementary forms which go to make the skeleton usually found in churches, are floors, columns, cantilevers, arches, roofs often with very long spans, consoles, and domes. As an expert in the proper use of adopting reinforced concrete to church building might be mentioned Professor Fisher, in Munich. He has not only used this material in the construction of the skeleton of the new garrison church in Ulm, but given it equal prominence with natural masonry and brickwork, and it appears visible in the elevations; this is one of the first examples we have of this material being used in such a way in large European buildings of an ecclesiastical type. The aforementioned architect obtains without any great expense in this church a span

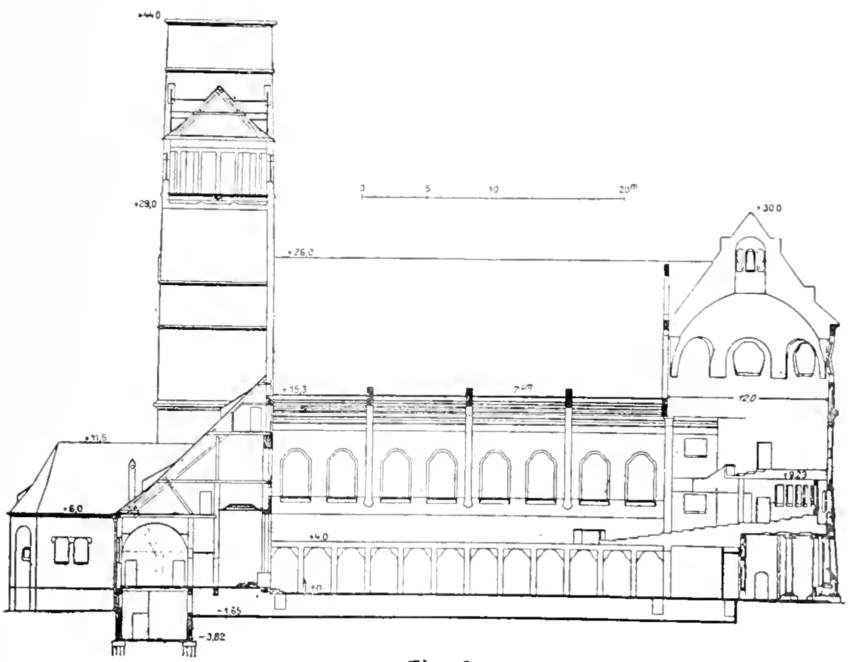


Fig. 2.

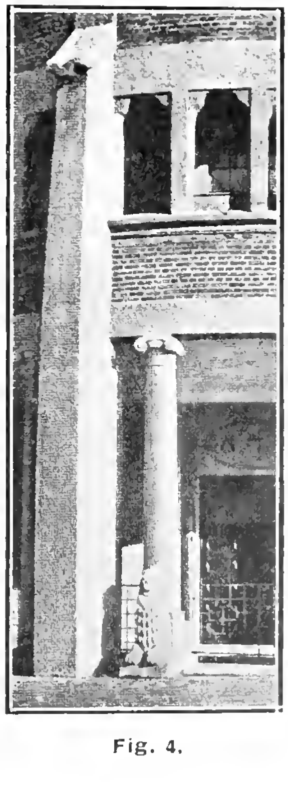


Fig. 4.

which has never been exceeded in any other church of solid masonry. In our medieval cathedrals there are very few spans above 50 feet; the renaissance builders were the first as opposed to the gothic to strive after an effect of spacious-

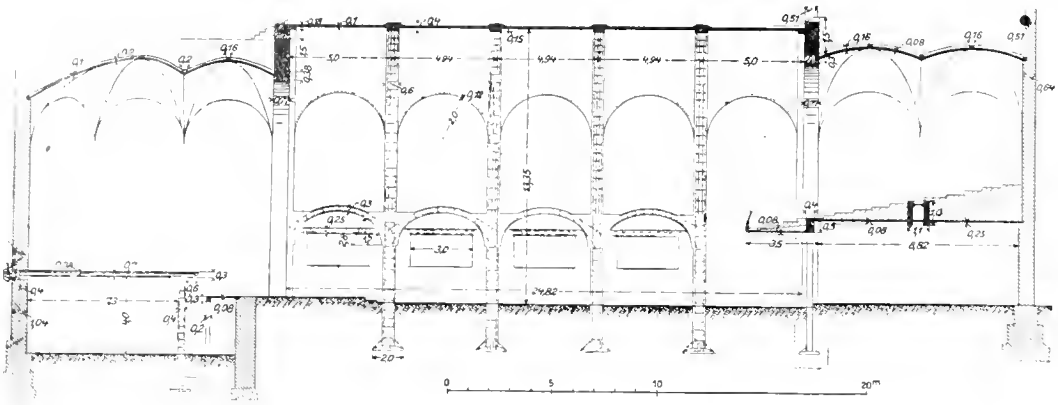


Fig. 5.

ness, which was obtained by enlarging the main dimensions. In the Cathedral of Florence a span of 56 feet was obtained and at St. Peter's, in Rome, the maximum 75 feet was reached. Considering the cost and time which only some few decades ago were necessary to solve similar problems, it will be at once seen how reinforced concrete has accelerated architectural progress.

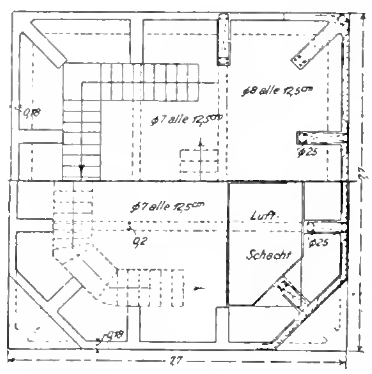


Fig. 7.

Fig. 1 shows the exterior of the church with the concrete parts easily recognizable in the buttresses and in the organ wing. The church consists of three main parts, the nave proper, the organ wing and the two towers with connecting walls containing classrooms for confirmation and the sacristy. Except the towers, in which only the floors and the main cornice are built in reinforced concrete, all the other supports are of this material. There is not a single cut stone existing in the whole building, the corner "stone" also, which was laid by the King of Wurtemberg, was of concrete. The construction in the organ wing does not differ very much from forms in common use outside the fact that there are some cantilevers carrying the galleries with a free span of 25 feet, a roof with 40 feet span and a dome. The more interesting points of construction are to be found in the nave (Fig. 2). The foundation consists of 35-foot-long concrete piles, each capable of carrying 55,000 pounds. These were tested and found entirely safe for 85,000 pounds. The nave is 75

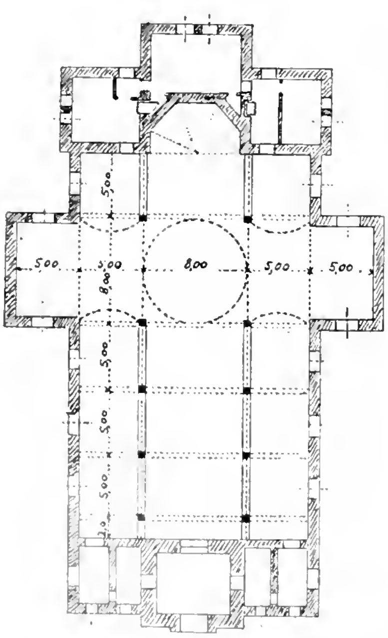


Fig. 9.

feet broad, 100 feet long and 30 feet high and is built up of four enormous girders in arch form. (Fig. 3). Between these spans a slab and beam ceiling forms the vault over the church. The distance between the girders, which are 1½ feet in width, is 25 feet, and in designing these the architect only took the architectural requirements for a good design into consideration, not being bound in any way by the material.

Running lengthways in the side walls of the nave (Fig. 3) are reinforced concrete beams supported by the columns, partly forming the plinth and cornice and partly carrying the brickwork filling which is 12 inches thick.

All concrete surfaces are unplastered, but treated as cut stones and bush hammered. Fig. 4 shows a part of the exterior of the organ wing. The special concrete mixture, used in the exterior, consists of 1 cement, 1 sand and 2 gravel of pea size.

By using a special mixture and afterwards washing and

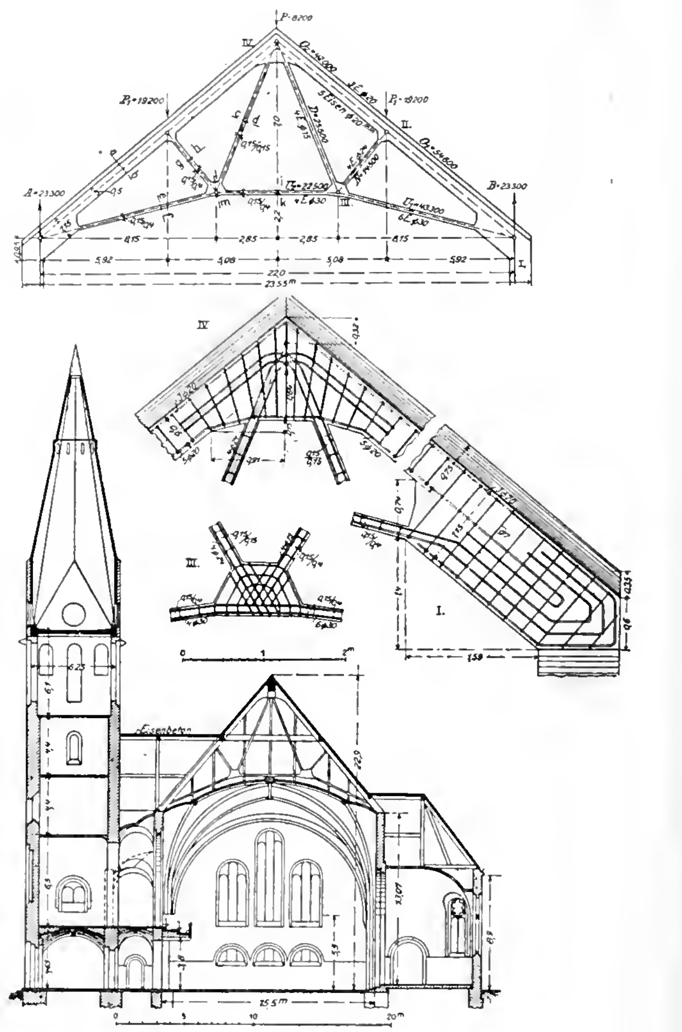


Fig. 8.

brushing it, a surface more natural to the properties of the concrete would be obtained.

For relieving the monotonous grey concrete surfaces inside the church the architect has inlaid small colored (white, black, green and blue) tiles into the soffits of the arches and

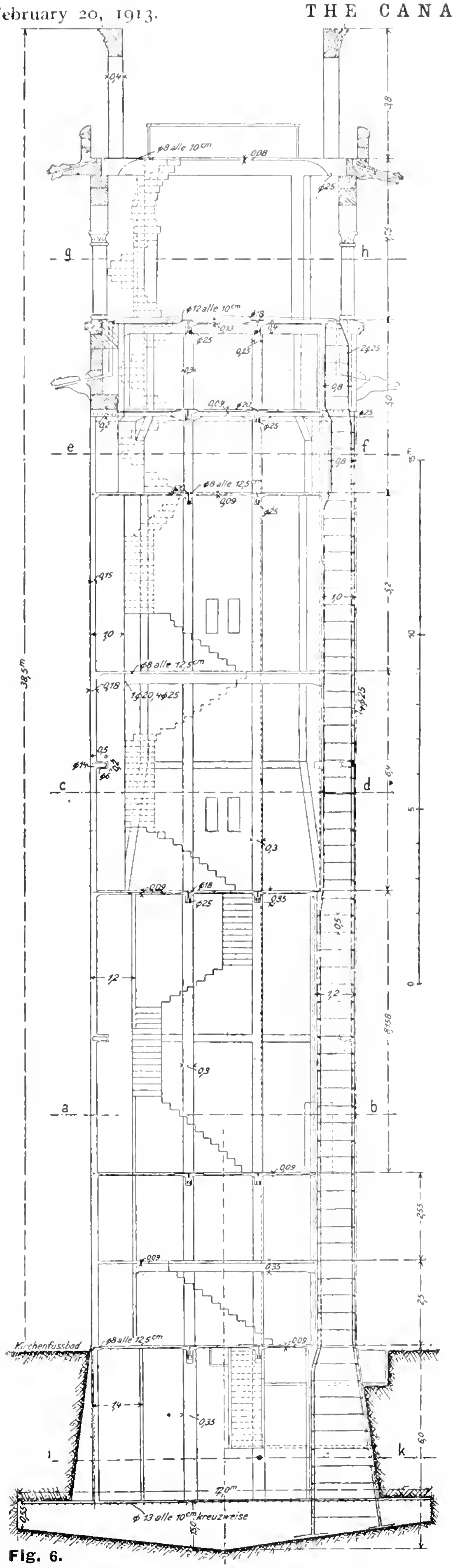


Fig. 6.

the beams. The placing of these hard-burnt glazed tiles [in] the concrete has produced a very good effect; such a ceramic embellishment may perhaps be developed further and in other positions, also to good effect.

In the Markus church, in Stuttgart, the nave is also built up of reinforced concrete arch girders. It is 80 feet long, 50

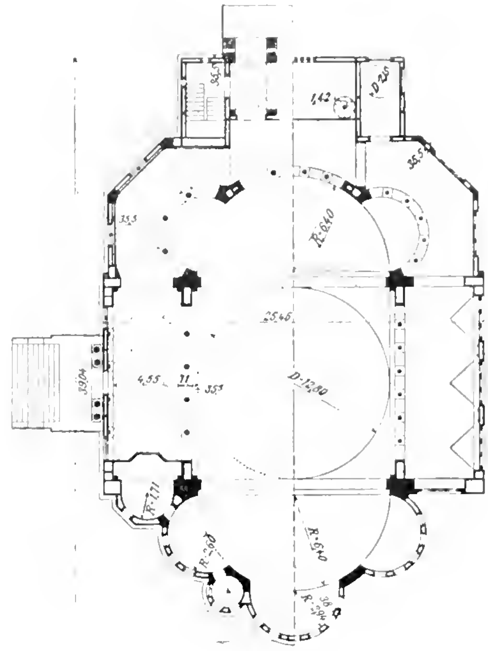


Fig. 10.

feet broad and 45 feet high. Attached to it are two side naves 9 feet broad and 15 feet high. The arch over the main nave consists of the said arch girders, spaced 16 feet centre to centre (Fig. 5) connected by a 4-inch-thick concrete slab. As the architect only permitted 6 inches of the girders to be visible under the slab the rest of the thickness was was placed over the slab. Downward, the arch girders go over into the columns, in which the beams and columns for the side

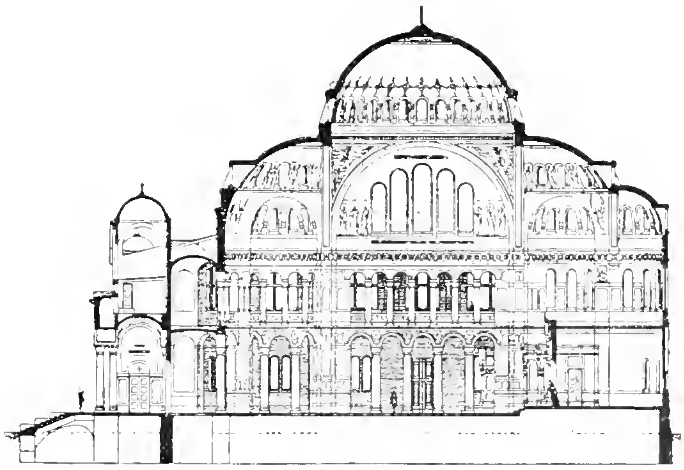


Fig. 11.

naves are also fixed, so that the frame for the three naves forms a monolithic, connected whole, of great strength and stiffness.

An interesting feature in this church is that the 190-foot-high tower is built up in reinforced concrete. After careful examination and deliberation the leading consultants for this church building decided upon the use of this material, apart from any question of economy, being of the opinion that its employment minimized the possibility of cracks arising from

the swinging of the bells to a greater degree than in any other material, and also that it offered the greatest resistance in proportion to its weight, and was capable of resisting tensile as well as compression stresses, and in addition to these advantages was perfectly fireproof.

The tower (Figs. 6 and 7) rests on 12 reinforced concrete columns connected with 8-inch-thick concrete walls; they go

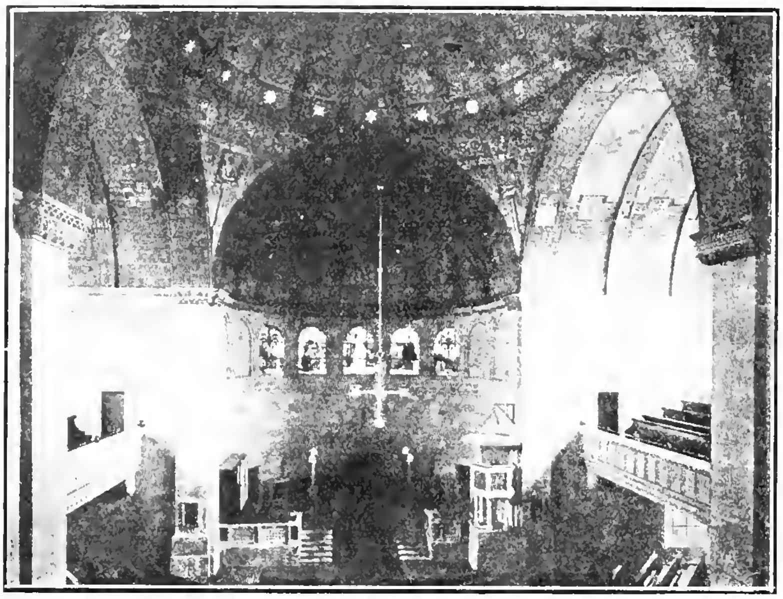


Fig. 12.

along the total height of the tower and are at the base 1 foot by 7 feet, and at the top 1 foot by 2½ feet. They are stiffened laterally by the floors. The foundation slab, 40 feet square, is situated 20 feet under the church floor, from this slab and up to a height of 60 feet the tower is 25 feet by 25 feet. From that elevation the corners are taken off so that it continues as an octagon. In elevation 90 feet above the floor the reinforced concrete walls stop short and are continued in brick. Over the room for the bells are only four columns carrying the last story, 16 feet high.

The bells are hung up in a special manner (Kurz system) which causes the tongue of the bell to meet the clapper when it is inclined at about 45 degrees to the vertical, and both are swinging outwards as opposed to many other systems, in which the tongue meets the clapper during the backward swing, thus causing greater impact stresses in the tower. After the Kurz system church bells have been built up to 13,000 lbs. weight, and are capable of being rung by only two men.

In the garrison church in Kiel the roof, the top of the tower and the gallery pews are constructed in reinforced concrete. The roof (Fig. 8) is supported by two diagonal Polonceau trusses of 75-foot span, built entirely of concrete and reinforced with thin bars. The tower top, placed upon the 85-foot-high brick tower, has 4-inch-thick walls, is 21 feet square at the base and 65 feet high.

In Russia reinforced concrete has already been in use for over 10 years in church buildings, not only in the greater cities but even in the villages, where one would think that the very low temperature during the long winter, the difficulty of transport and of getting the necessary able labors would throw insuperable obstacles in the way. This view (Fig. 9) shows the typical plan of such a village church and with the interior entirely built up in reinforced concrete. The roof slab is supported by concrete beams with 26-foot span between the columns and 16 feet between the brick walls and columns. Not only in those churches roofed by arches but also in those roofed by domes a great number are to be found in which reinforced concrete is employed.

One of the most interesting and characteristic examples is the church in the Russian city, Poti, situated in the swampy delta territory between the Black Sea and the Caspian.

As at the outset the cost prohibited the carrying of the foundation 70 feet deep through shifty sand down to firm ground, the chief consideration was to reduce the weight of the walls and domes to a minimum. Of the schemes sent in, the reinforced concrete one was selected, which not only met these requirements, but was the cheapest and also the most expeditious in spite of the fact that the work had to be performed by unskilled local labor. The walls are only 14 inches thick, including a 7-inch-thick airspace. The main piers, in accordance with the architect's desire for massive exterior, are built hollow (Fig. 10) containing pipes for heating and ventilation. The roof is formed of one main dome (Fig. 11) with 42-foot span and attached to this are two half-domes and to one of these again smaller half-domes.

A dome of similar size is built in reinforced concrete in Christ Church in Dusseldorf (Fig. 12). This dome is supported by four arch girders of 45-foot span, and over these four parabolic arches are arranged, carrying the weight of the tower.

The dome in Los Angeles, with its 62-foot span, (described in the February 6th, 1913, issue of The Canadian Engineer) is still one of the largest church domes built in reinforced concrete, but in other classes of buildings this width has in many cases been surpassed. For instance, the span of the dome shown in Fig. 13 is nearly 100 feet, and at the present time one with 200 feet span is under construction.

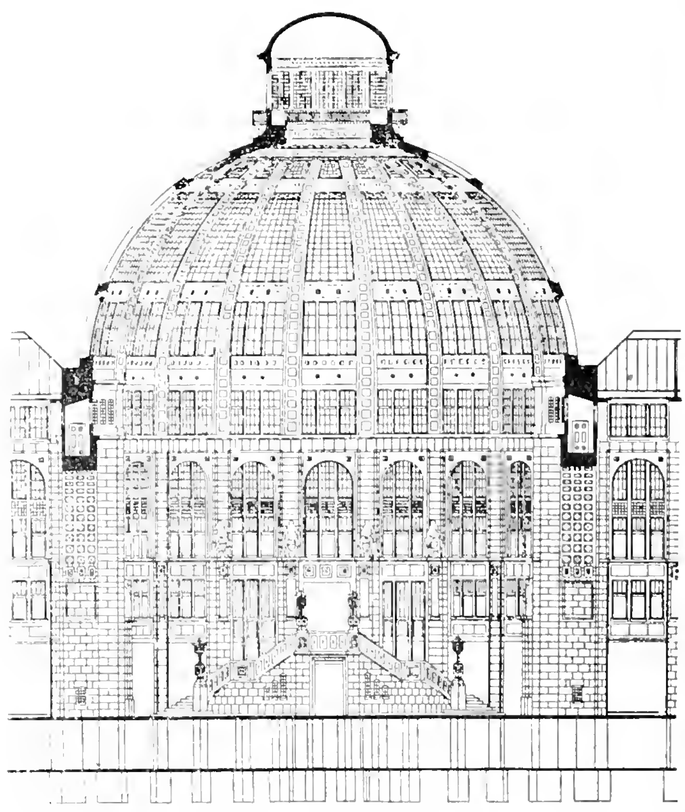


Fig. 13.

A LARGE REINFORCED CONCRETE STANDPIPE.

The details of the design of the 300,000-gallon reinforced concrete standpipe which was recently constructed in the town of Penetanguishene, Ontario, are shown herewith in Fig. 1. This tank is described in a recent issue of Engineering and Contracting. As will be noted from the drawings, the tank is 50 ft. in diameter and 21 ft. deep. The side walls are of 1:1:2 concrete, 12 ins. thick at the base and 8 ins. thick at the top. The walls are made thicker than necessary for strength in order to prevent the formation of a thick ice crust. The tank is covered by a reinforced concrete dome of a height of 1/10 of the diameter. It is 4 ins. thick and is reinforced by ⅜-in. bars 12-in. on centres.

The tank was built in about six weeks during October and the early portion of November of 1912. It was filled the latter part of December, and did not show a leak or sweating at the first filling nor thereafter.

The reinforcement of the shell was figured by a method not ordinarily used in the United States. If we consider a a shell alone and assume that it is not connected with the bottom, it will increase in size as shown by curve A of Fig. 2. Inasmuch as the shell is connected with the bottom, and besides rests on the ground, it cannot elongate at the bottom, and if a proper connection is made between the side walls and bottom, the lowest portion of the shell cannot even change its directions at the bottom; or, in other words, it is fixed at the bottom. Hence, the real deformation of the shell will be a line somewhere as shown by curve B in Fig. 2. It clearly depends on the thickness and height of the shell where the deviation from the ideal line of deformation stops.

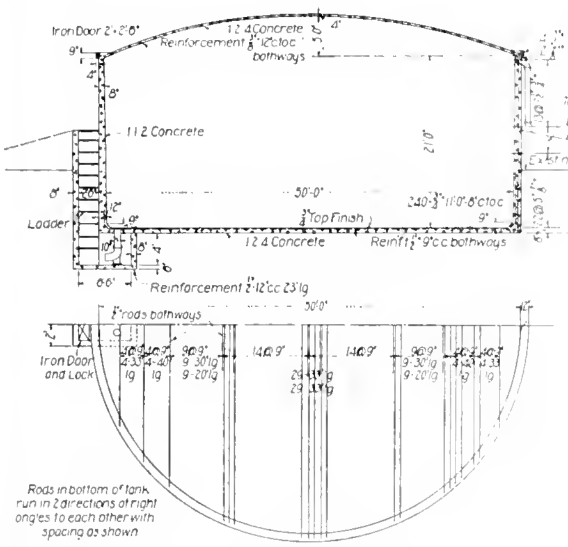


Fig. 1.—Details of Design of New 300,000-Gallon Reinforced Concrete Standpipe for Penetanguishene, Ontario, Waterworks.

This problem was first investigated by Professor Grashof, and published in his book on "Theory of Elasticity" in 1878. The differential equations governing the conditions are, however, of a high order, and even in the simplest case where the walls are of uniform thickness, the equations for the elastic curve are expressed in periodical functions and it takes several days' labor to solve a single problem. The equation cannot be solved for walls of various thicknesses, as the integrals of the differential equations are unknown up to this day. However, the elastic equations clearly show that the shape of the elastic curve is a function of $\frac{h^2}{rt}$, wherein h is the height of the tank, r the radius of the tank, and t the thickness of the shell at the base, all being expressed, of course, in the same unit.

In the present case $\frac{h^2}{rt}$ equals 16 and the elastic curve for this case only starts to deviate abruptly from the ideal deformation at the point of 4/10 h above the base, as shown in Fig. 2, curve B. This means that the water pressure corresponding to the shaded portions is not taken up by the ring action but by the cantilever action of the connection of base and shell. After a little consideration, it will be clear that there must be acting on the ideal beam, for this case a force above the 4/10 h point, which tends to bend it back into the

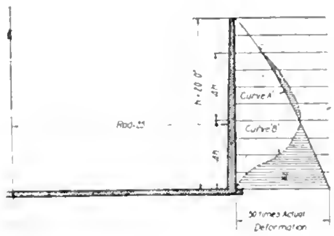


Fig. 2. Deformation Diagram.

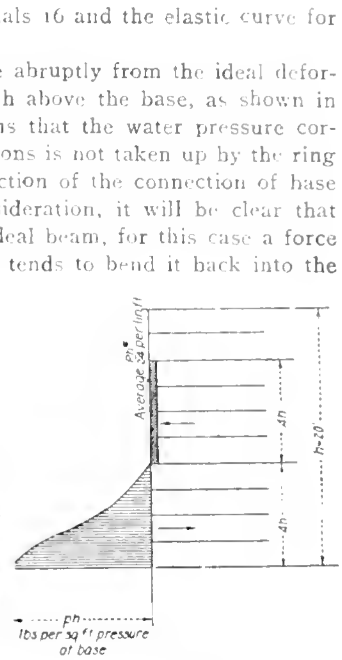


Fig. 3. Loading on Ideal Beam.

line formed by the ideal deformation of the ring sections, as the cantilever would tend to bend the top portion further out and the deformation on top must be zero from the nature of the case. This force is nearly a uniform load also for a height of 4/10 h in this case and equals approximately $\frac{ph}{24}$ in this case. Now, if a beam is assumed which is acted upon by the forces as shown in Fig. 3, we can find the elastic curve from the equation $\frac{d^2y}{dx^2} = -\frac{M}{EI}$, wherein M is the moment at any section x feet from the top, E the modulus of elasticity and I the moment of inertia at the section x. If the assumption of the form and position of curve B of Fig. 2 is correct, the elastic curve obtained by the foregoing general equation must be identical with curve B. This agreement can be reached after a few trials.

It is also clear that there exists beside the negative moment at the bottom of the shell on the inside, a positive moment higher up on the outside of the shell. The maximum value of this positive moment occurs where the shear passes through the zero value. The shear at the bottom of the shell can also be obtained from Fig. 3. This shearing stress governs the reinforcing of the bottom of the tank. The moment at the bottom of the shell, in this case is about

$$\frac{ph^3}{66} = \frac{62.5 \times 20^3}{66} = 7{,}600 \text{ ft.-lbs. per lin. ft.}$$

The reinforcing here adopted is more than ample. The positive moment on the outside of the shell is $\frac{ph^3}{217}$, which can be taken up by the concrete without reinforcing. If the reinforcement at the bottom of the shell be omitted, the tank will first crack on the inside of the shell at the junction with the bottom, and then a larger bending moment will appear on the outside of the tank $= \frac{ph^3}{163}$ in this case. This

bending moment is already large enough to cause cracking of the concrete at the surface of separation between the portions placed on different days.

For other values of $\frac{h^2}{rt}$ the shape of the elastic curve is, of course, different from that here shown as curve B of Fig. 2. The greater the value of $\frac{h^2}{rt}$ the lower the point where the curve deviates from the ideal deformation of the ring sections.

The standpipe here described was designed and built by L. J. Mensch, M.Am.Soc.C.E., of Chicago.

STREET AND RAILWAY TRACK PAVING WITH ASPHALT BLOCK IN A SUBURBAN TOWN.*

By Frank Chappell, Town Engineer, Oshawa, Ont.

It is possible that few Ontario towns have labored under more adverse conditions to secure a permanent pavement than has been the case with the town of Oshawa. It is certain that but few towns had greater need of pavement. Oshawa is a thriving manufacturing town, 34 miles east of Toronto and within four miles of Lake Ontario. The centre of the town lies in a hollow in what is said was formerly a cedar swamp. While excavating for a catch basin, a row of logs side by side—a relic of an old corduroy road—was found, six feet below the surface of the present street. This fact alone would suggest the difficult nature of the soil to be contended with.

Then again, the street railway company in Oshawa, operate under a Dominion Government Charter granted them about seventeen years ago. By reason of the looseness of agreements and by-laws drawn up between them and the town at that time, the street railway company are not obliged to pave between their tracks or pay any proportion of the cost of such paving. This refusal of the company to recognize any obligation or necessity on their part of paving their right of way, was the greatest stumbling block. Special legislation was at last secured, however, permitting the corporation to finance the whole work as a local improvement, the railway company agreeing to relay its track to conform to the new grade established, and further agreeing to pay a portion (amounting to only about 65 per cent.), of the extra cost incurred in placing concrete under the ties. This percentage, moreover, was to be made payable over a period of 20 years. It might be well to state here that railway companies, making overtures to pass over the streets of Oshawa now, are not allowed to slip easily through, but on the contrary have to face and commit themselves to the most binding legal documents it is possible to execute.

The selection of a pavement had again and again been discussed. One year the cheapness of construction of Macadam road proved an attraction, but after a short strip had been constructed upon one of the main residential streets, it was found to be so dusty in summer and so muddy in the spring and fall of the year as to preclude its usefullness in the business portion of the town. The desirability of a plain concrete pavement was then discussed, mainly because of its reported cheapness. The poor economy of these cheap ideas are the biggest drawbacks to communities in the transitory stage from village to town, and from town to city. While the concrete pavement in this instance would have been an interesting experiment, it was, however, voted down by the people immediately concerned.

The asphalt block pavement upon a concrete base was finally chosen after the mature deliberation of all parties. A sheet asphalt pavement is beyond the reach of a small town because of the expensive plant necessary at all times to handle the construction or repairs which might be required. Each asphalt block, however, may be regarded as an asphalt pavement in miniature, its composition and manufacture approaching to a considerable extent that of sheet asphalt. When well laid, the blocks, while possessing many of the desirable qualities lack one extremely undesirable feature of sheet asphalt, namely local creeping.

The streets to be paved in Oshawa, were the two main thoroughfares, which intersect each other at right angles in the centre of the town. The street railway track lies along both streets. In order that the contractors might have every facility for carrying their work to a successful issue, the work was divided into four blocks or sections, and all adjacent street intersections were closed to traffic while any particular section was being constructed. In each case the work was started at the extreme end of a section and progress was made towards the centre—known locally as the four corners.

The traffic was thus but little inconvenienced, for while the last portion was being completed in the centre, the other streets and intersections were open for traffic. Moreover, by closing the street against traffic of any kind, it was possible to make a more satisfactory job of the track work, as well as giving the road a greater period for setting and seasoning before use. The first step taken in construction was to make all sewer, water and gas connections, even vacant lots being connected. The whole of this work was well filled in and soaked down with water.

Grade stakes were set out on each side of the street and driven to the proposed elevation of top of curb. This was also the new elevation of each rail. In the meantime the track was completely dismantled, and the old ties hauled away, while the rails and angle bars were thrown on the boulevard. Excavation was proceeded with to a sub-grade eight inches below the finished surface of the pavement. In the centre, corresponding with the street railway allowance a shallow trench, 9 ft. 6 ins. wide, was excavated eighteen inches below the finished surface. This would allow eight inches of concrete to be deposited below the ties, and about one foot beyond the ends.

Concrete in the specified proportions of one to nine, but actually nearer one to seven (an alteration necessary on account of the grading of the gravel), was placed in this trench to a depth of six inches. Within twenty-four hours the ties were laid on this and after the rails had been spiked and jointed, were brought to grade with wooden shims, about three or four to the rail. This left a two inch space to be filled with concrete. Great care had of necessity to be observed, in order to pack the concrete under the ties, and a very wet concrete was used, entirely free from large stones. This was done as it was believed that the ties would be more securely bedded in the concrete than if the whole eight inches had been filled at once. Furthermore the track was more easily and accurately brought to grade with this two inches of play.

The method of laying the ties and rails and subsequently raising to grade on the first six inch layer of concrete is avoided by contractors because of traversing the work twice with concrete mixers, etc. In over a mile of similar work done later this method was insisted upon, however, by the writer, and is still believed to be a far better plan than to lay the concrete all at once. The rails and ties if graded up to their

*Paper presented to the Canadian Society of Civil Engineers, February 6, 1913.

proper position are so easily disturbed by gravel teams, wheel barrows, etc., while a much longer period is necessary for the setting of such a thickness of concrete—longer than is permissible in street paving work. The second application of concrete was made at the same time that the base was being laid for both sides of the road. The curbs were also prepared at the same time, the base and sides thus being practically monolithic.

As far as track construction is concerned it is not pretended for one moment that the work described in this paper is by any means ideal. As noted in the preamble, the corporation was largely at the mercy of the railway company, which refused to admit any obligation. So when the company insisted on using old 56-lb. T. rails, 4" deep, which had been in constant use for nearly twenty years, the only thing to be done was to make the best of such unfavorable material. New ties were provided of Norway pine, but the old angle bars were used. This in particular was a point to which the writer was strongly opposed. For such rails, the writer recommended that the ends of the old rails be cut off and that they be redrilled.

Moreover, a continuous bar joint was to be used. The reason for this was, that in using the old rails and old bars after they had been once dismantled, different bars would probably be connecting other joints. Now these bars during their long service, some 15 to 20 years, would have acquired a "set" in some direction, and this could certainly not be taken out by merely tightening the bolts in re-jointing. However, this was over-ruled by the company, and the only pieces of track replaced with new material were a few split rails and defective switches. The fallacy of expecting a miscellaneous collection of angle bars to fit an equally miscellaneous quantity of defective rails was amply proven in less than six months after the work was completed.

The concrete base was well laid and is an excellent piece of work. It is possible now, however, in less than a year, to stand on a rail joint and cause a perceptible vibration with one's foot. The effect can be imagined, therefore, of street cars hammering on such joints. Even the railroad authorities now admit the poor economy shown in such parsimonious construction, and later work has been done with heavier rails having newly cut ends and new bars, although the continuous bar-joint which the writer believes is absolutely necessary in street railway work is still kept out, only, however, on the score of extra expense. The ties were laid at two foot centres with additional ties thrust under the joints. With the second layer of concrete, the ties became perfectly embedded at the ends, sides, and over the top.

The whole base was now ready for block laying and this took place usually within about three days of the concrete base being laid. A slightly dampened mixture of cement and sand in the proportions of 1 to 3 was distributed over the concrete surface to a uniform thickness of one-half an inch. Between the rails allowance was made so that a crown of half an inch could be given the blocks. The blocks were laid upon this cushion of cement and sand, and then rolled with a heavy hand roller of from three to four tons weight. The surface was then minutely inspected for any imperfectly bedded blocks, which were at once removed with specially shaped tongs, and a small portion of cement cushion placed so that the block would not rock. The blocks were laid between the rails in the same line as the rail. Now this is a nice looking piece of construction and it also has the advantage of being very easy to lay, and furthermore the number of "bats," or broken blocks, is considerably reduced.

The writer has noticed, however, that where cars have been derailed, the tendency is to open up the unbroken course for a considerable distance, should the car wheel strike the longitudinal joint. It is a question that [illegible] well to note, as to whether any greater advantage is gained over this method by the more expensive work of cutting and fitting blocks within the track, at right angles to the line of traffic.

The fact that the blocks were laid in the same line as the rail is another regrettable instance of the overruling of the professional man by the lay man. Two and one-half inch blocks are too small for railroad work in the first place. The street car wheels abrade a place for themselves assisted by external traffic to a depth of about one and one-half inches. This then leaves but one inch of block to resist any lateral pressure which may be brought to bear by vehicles crossing a street diagonally. The result is that a block becomes loosened when laid in the same line as the rail by reason of the open surface offered by its longer side. As soon as one block is thrown out it is less difficult to loosen others. If the blocks had been laid in this instance as specified, at right angles to the rail, there would have been at least greater holding surface.

After all blocks had been rolled, examined and found to "bed" properly, the surface was sprayed with water from a fine nozzle. A cement grout was then prepared in equal proportions of cement and sand. This was poured over the blocks and brushed well into all joints and interstices. As this grout dried out it settled until the joints were only about three parts full. A second application of a stronger grout was then applied, two parts cement to one part sand, and this mixture was brushed into the joints until they were packed full. As the rails in the track were T rails, a space about two inches wide was left on the inside of each rail to be worked into a groove for the flanges of the car wheels.

A concrete of crushed granite and cement was packed well into this space and shaped with a tool to the required width and depth. This has proven a very satisfactory piece of work and while undoubtedly cheaper, it is in the opinion of the writer, under certain conditions even to be preferred to scoria blocks and granite "setts." The car wheels crush and abrade the concrete and the edges of the blocks to an extent necessary for clearance and after a little wear, a smooth uniform groove is made. The blocks are soft enough to yield to the abrading action of the car wheels without loosening the joints, while the little inequalities in the concrete groove are subject to direct crushing.

With reference to the concrete groove between the blocks and the rail, this too would probably have shown to greater advantage had a thicker block been used, say 3" or 4". This, of course, was not possible on account of the 4" rail in use. There is this about the concrete groove, however, that when abrasion occurs the dust that is produced washes away and the groove has that much less material. To overcome this the writer has since tried on over a mile of road, a groove filler of a mixture of bitumen and broken stone. This is almost a ductile composition and it is possible that, in warm weather, at any rate, the bituminous mass will accommodate itself to the groove, and give better results than similarly placed cement.

In connection with turnouts and switches, the triangular space facing the frog gave considerable difficulty. Blocks were in the first place cut and fitted and grouted in. The space was so narrow, however, that the wheels would push them out of place. Concrete of the same consistency as the groove was next tried, being one part cement, one part sand and three parts crushed granite. This, in some instances, lasted no longer than the blocks, while even where car traffic was infrequent, although the life was much longer the result was not satisfactory. A plate of hard grey cast iron, called by the author, a "frog piece," was at last substituted and drilled and spiked to the ties with the countersunk

spikes. The blocks were paved up to this and the whole cemented in.

This cast iron frog piece is, as far as the writer knows, entirely original and has proven a distinct success. Neither the castings or the adjacent blocks have moved in the least, and this method was adopted at seven different turnouts. Three turnouts were left without such provision and blocks, concrete, etc., were tried out, but without success. These will now be fitted with cast iron plates. The pavement, except for the street railway work, has shown up very satisfactory so far. The blocks appear to be uniform and there are no inequalities in the pavement, the only trouble being with the before-mentioned blocks in the track allowance.

The diamond used in the centre of the town is of an altogether too light and flimsy nature. It consists simply of rails four inches in depth, bolted together on plates at the corners and with cross braces in the centre. This should at least have been made of heavier rails of the "girder" type, although there are cast steel diamonds made which have given great satisfaction, and are undoubtedly to be preferred. The result of using the poor diamond above described has been to loosen all the blocks inside and the blocks for a distance of about four feet outside the rails. Repairs are being made on this work at the time of writing.

All headers at street intersections were made of granite concrete, as for curb, and extended twelve inches beyond and to the full depth of the pavement base. This has proven very satisfactory, although the writer believes that it should be carried further—say two feet beyond the pavement, where the intersecting street is unpaved.

The following data may be of interest:—

Price of gravel, deposited on work by teams at contract price	$1.00 cu. yd.
Price of cement deposited in shacks	1.52 barrel
Superficial prices:—	
Excavation and grading	17 sq. yd.
Concrete base (5″)	53 sq. yd.
Blocklaying and ½″ cushion	22 sq. yd.
Blocks—teamed on to the work (freight Windsor to Oshawa inclusive)	1.57 sq. yd.
Cubic yard prices for work under track:—	
Excavation	50 cu. yd.
Concrete base	4.68 cu. yd.
Curb and gutter	56 lin. ft.
Average cost of catch basins	24.00 each
Total cost per lineal ft. of 40 ft. road	14.84
" " " " 35 " "	12.98
" " " " 30 " "	11.12

These measurements are taken from face to face of curb.

This last table of total costs includes paving the street, laying curb and gutter, paving the track allowance, extra concrete under the ties, the dismantling and relaying of the track, together with all catch-basins, etc., required.

The total yardage of the pavement was 14,300 sq. yds., and the total cost including the foregoing incidentals was $47,750.00.

GRAND TRUNK EQUIPMENT ORDERS.

Orders have been placed by the Grand Trunk system for locomotives as follows for the coming year: 25 Mikado type from the American Locomotive Works, Schenectady, N.Y.; 50 Pacific type from the Baldwin Locomotive Works, Philadelphia, and 15 large standard switching engines from the Canadian Locomotive Works at Kingston. The Mikado locomotives are larger than any locomotives now in use in Canada. Ten Pacific engines have also been ordered from the Montreal Locomotive Works.

RAILWAY FINANCING LAST YEAR

During the past ten years Canada has experienced a wonderful era of expansion in railway building, which has had a marked influence on the development of the country from shore to shore. Probably in no other country have such determined efforts been made to provide transportation facilities, and the rapid rise in importance of Western Canada is an eloquent tribute to this far-sighted and courageous policy. The total railway issues for 1912, according to Mr. E. R. Wood's bond review, were $69,972,320, almost the same as the aggregate for 1910, but falling considerably below the record of 1911—$100,472,700.

Of the railway bond issues, $61,382,320, or 87.73 per cent., found a market in Great Britain, while Canada took .21 per cent., and the United States 12.06 per cent. Great Britain continues to finance the greater part of our railway development. These issues and the markets in which they were sold are set forth in the following table:—

RAILWAY ISSUES.

Company.	Amount.	United. States.	Great Britain.
Canadian Pacific Railway 4% Consolidated Debenture Stock	$10,962,320	....	$10,962,320
Grand Trunk Railway 4% Perpetual Consolidated Debenture Stock	12,500,000	....	12,500,000
Grand Trunk Railway Equipment Trust Notes, Series "A"	3,940,000	$3,440,000	500,000
Grand Trunk Railway Equipment Trust Notes, Series "B"	3,360,000	3,000,000	360,000
Canadian Northern Railway 4% Perpetual Consolidated Debenture Stock	6,960,000	....	6,960,000
Canadian Northern Railway 5% Income Charge Convertible Debenture Stock	10,000,000	....	10,000,000
Canadian Northern Railway Equipment Trust Notes, Series "C 1"	2,000,000	2,000,000	....
Canadian Northern Railway Equipment Trust Notes, Series "D 1"	3,000,000	3,000,000	....
Canadian Northern Railway Equipment Trust Notes, Series "E 1"	2,000,000	1,850,000	....
Canadian Northern Pacific Railway 4% Debenture Stock (guaranteed by British Columbia)	5,000,000	....	5,000,000
St. John and Quebec Railway 4% Stock (guaranteed by New Brunswick)	4,250,000	....	4,250,000
Edmonton, Dunvegan and British Columbia Railway 4% Debenture Stock (guaranteed by Alberta)	3,500,000	....	3,500,000
Algoma Central Terminals Limited 5% Bonds (guaranteed by Lake Superior Corporation)	2,500,000	....	2,500,000
	$69,972,320	$8,440,000	$61,382,320

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., EDITOR — A. E. JENNINGS, ADVERTISING MANAGER — P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, FEBRUARY 20, 1913. No. 8

CONTENTS OF THIS ISSUE.

THE SUGGESTED CHANGES IN THE ONTARIO RAILWAY AND MUNICIPAL BOARD ACT.

The powers of the Ontario Railway and Municipal Board will be considerably enlarged if the proposed Ontario Railway Act, now before the Provincial Legislature, is enacted.

A clause which will have far-reaching effects, is that dealing with the right of the Board to order the construction of spur lines or branches upon the application of an industry. This clause, if adopted, will give the Board power, where any industry lying within six miles of a railway desires shipping facilities and cannot agree with the railway company as to construction and operation of a spur, to order the railway to construct and operate such a line. It may also direct the applicant to deposit in a chartered bank a sum sufficient to construct and complete the spur, and this amount can be paid by the Board to the railway from time to time as the work proceeds.

The aggregate amount so paid by the applicant in the construction and completion of the spur line shall be repaid or refunded to him by the company by way of rebate to be fixed by the Board, out of the tolls charged by the railway company upon the traffic over the branch.

Until the total amount of the cost of construction is repaid, the applicant retains a special lien for this amount on the line; when payment has been received by the applicant, the railway then receives total ownership of the spur.

The old section of the Act, which this clause replaces, entails very roundabout methods, and operates by means of the submission of a by-law. The Board has no mandatory powers under the present Act to enable it to see that its wishes are carried out. This change, if adopted, will be instrumental in securing quicker action, and should work to the advantage of both the railway and the applicant.

Another important change is that providing that a general preliminary plan of a new railway must be filed before the Board. These plans must show the location of the line, the towns through which it passes, the rivers or other railways covered or within a radius of thirty miles. The Board is given the power to approve these plans and to alter them if deemed necessary.

GOOD ROADS.

History repeats itself. The world is again assuming the Roman attitude toward good roads problems. Neither technical education nor country residence is required to appreciate the value of good roads. Any town or village unfortunate enough to be off the railroad map is off every map unless good roads link it up with the world.

Yet it is surprising how many city bred men still believe good roads to be a useless expense—that is, until they buy their automobiles. And even a few farmers can be found here and there who are narrow-minded enough to begrudge a road tax. Educating the public to enthusiasm about good roads has naturally been a slow process, and there have been but few men in Canada who have had the patience and public spirit to keep at the educative task.

Among those whose efforts have not been in vain and who have done a great amount of very praiseworthy work without any hope of personal reward, have been the executive and members of the Ontario Good Roads Association. Special interest is aroused in the annual

meeting of this Association at Toronto next week owing to the co-operation which is being accorded to them so liberally at the present time by the Ontario Government. It is understood that the government has practically pledged itself to spend several millions, beginning early in 1914, upon good roads in the more settled parts of the Province. The Ministers are said to look with favor upon the Toronto to Hamilton, Ottawa to Prescott and Toronto to Montreal roads, and the construction of these much-needed highways at a comparatively early date is practically assured.

Had the Ontario Good Roads Association never done any other work, it has fully justified its existence by its splendid promotion and organization work in connection with these three roads. Some of the members of the Association have spent hundreds of dollars personally and given weeks of time to the work without any remuneration whatever. Their main task now seems to be securing Federal co-operation. It is to be hoped that some plan will be brought out at the Convention next week which will result in interesting the Dominion government to a greater extent than the Association has succeeded in doing in the past. With Federal aid the county councils should be able to afford any type of pavement which will be the best and cheapest ultimately, regardless of a possible higher first cost.

CANADA CREOSOTING COMPANY.

Forty acres of land on the river front at Trenton, Ont., have been purchased by the Canada Creosoting Company, which will erect a large plant for creosoting timber of all kinds.

The United States Wood Preserving Company and the American Creosoting Company jointly control the stock of the Canada Creosoting Company, but about one-third of the shareholders of the Canadian company will be residents of Canada, as a block of the stock of the new company is being sold privately in Canada. The head sales office of the new company will be at Montreal, where a tank station will be erected. Creosoting oils will be brought to the Montreal station in tank steamers from Europe. A small tank steamer, specially constructed for going through the St. Lawrence canals, will carry the oil from the Montreal station to the Trenton plant. Mr. E. S. Clements, of the United States Wood Preserving Company will be the Canadian manager, with headquarters at Montreal. President Hurt, of the American Creosoting Co., will be the president of the Canadian company. A. B. Clements, vice-president and general manager of the United States Wood Preserving Company, will be the vice-president.

The company will treat, principally, railroad ties and wood paving blocks, by the vacuum-pressure method. Approximately 150 men will be employed at the start. A plant costing in the neighborhood of $200,000, and with storage space for a million ties, will be erected at once. The company has purchased enough ground to be able to treble the initial capacity of the Trenton plant, and it is thought that within a year the capital of the Canadian company may be greatly increased and the plant considerably enlarged.

The Trenton plant will be practically a duplicate of the United States Wood Preserving Company's Toledo (Ohio) plant, which is said to be the most modern and best-equipped wood preserving plant in the United States. Three cylinders, each 190 feet in length, will be constructed at once for the creosoting process.

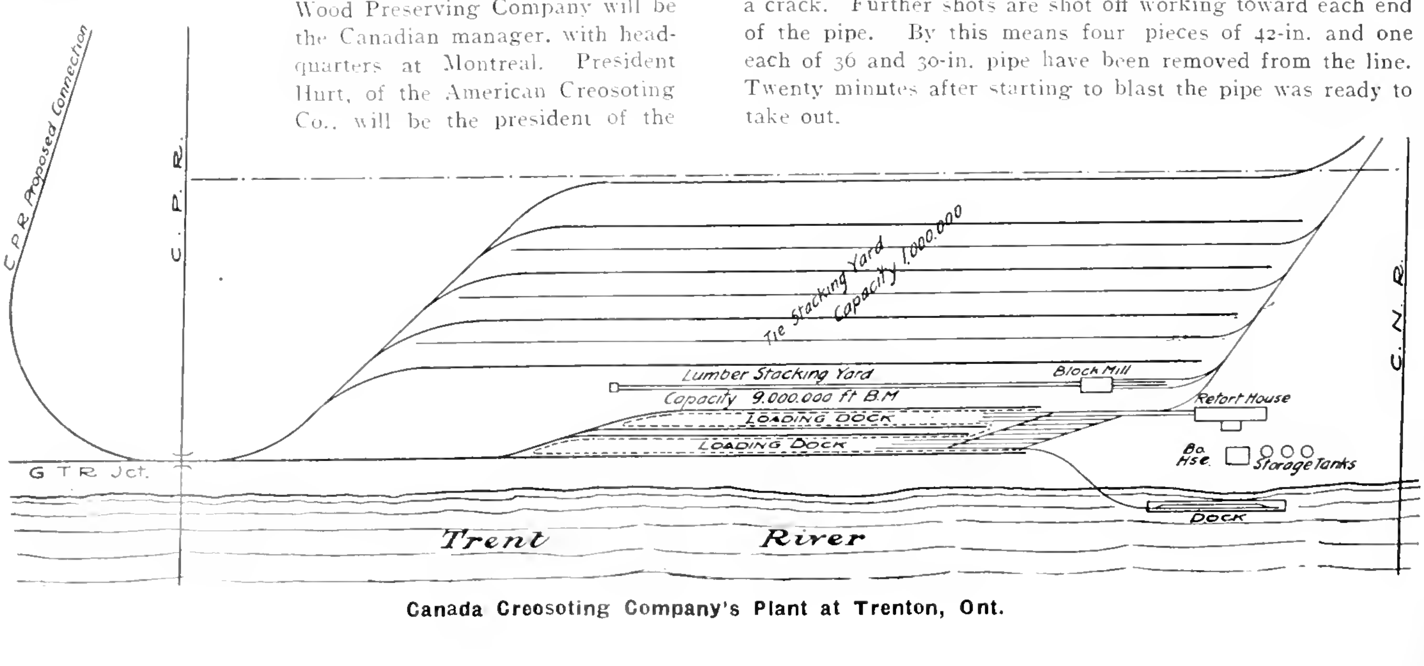
There are already two big plants in Canada engaged in preserving timber—those of the Dominion Tar & Chemical Company, Limited, at Transcona, near Winnipeg, and at Sydney, N.S. The Dominion Tar & Chemical Company produce their own creosoting oils at tar-distilling plants at Sault Ste. Marie, Ontario, and Sydney, N.S. It is not expected, however, that the Canada Creosoting Company will in any way conflict with the business of the Dominion Tar & Chemical Company, as there will undoubtedly be a tremendous call in the next decade in Canada for preservative treatments of timber, and the plants of both companies will probably be worked at full capacity.

The railroads save huge sums by having their ties creosoted, as it adds but little to their cost in comparison to the many years which it adds to the lifetime of the ties. Bridge timbers, piling, sheeting, shop and factory floors and wood for many other purposes can be very profitably creosoted

DYNAMITE FOR REMOVING BROKEN SECTIONS OF CAST IRON PIPE.

At the annual convention of the American Water Works Association, Mr. W. F. Wilcox described the use of dynamite for removing broken sections of large size cast iron pipe.

The method utilized is as follows: Starting in the centre of the pipe to be removed, place ¼ to ⅓ of a stick of 40 to 60 per cent. dynamite on top of the main and cover it with a handful of clay. The blast blows out a small hole or starts a crack. Further shots are shot off working toward each end of the pipe. By this means four pieces of 42-in. and one each of 36 and 30-in. pipe have been removed from the line. Twenty minutes after starting to blast the pipe was ready to take out.



Canada Creosoting Company's Plant at Trenton, Ont.

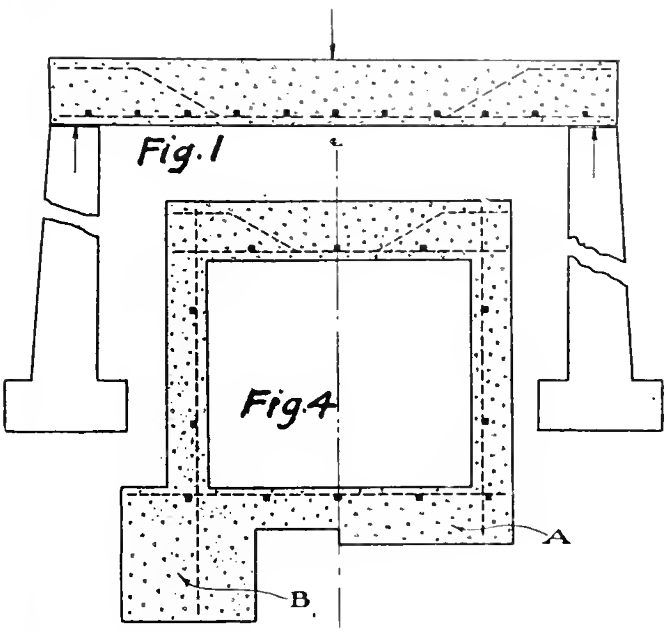
CONCRETE BRIDGES AND CULVERTS*.

In view of the fact that so many of the concrete highway bridges constructed in the last few years are composed of various combinations of simple beams and cantilevers, it may not be out of place before taking up the study of these various types to briefly summarize the laws governing the action of simple beams and cantilevers.

Figure 1 shows a simple slab or beam supported at the ends and loaded as indicated by the arrows. Under the action of the three forces as indicated, namely, the two abutment reactions and the load, the beam tends to deflect or bend at the centre, producing a crack or cracks extending from the bottom of the beam upward. The reinforcement is placed perpendicular to these cracks to carry the tension and thus prevent cracking of the concrete.

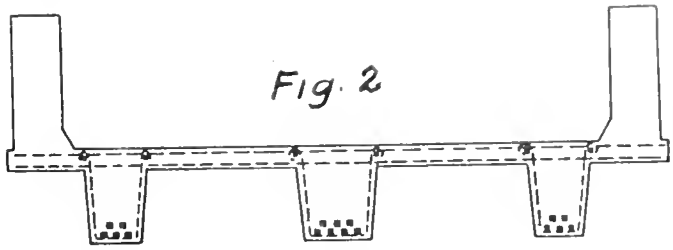
In the preceding case no account was taken of the shearing forces existing in the beam. Without going into the technical details, let it suffice to say that these shearing forces so modify the direct tension that, in addition to the tendency to crack at the centre, there is also a tendency toward the formation of cracks running diagonally upwards and toward the centre between the quarter point and the end of the beam. This is the so-called diagonal tension or shearing crack. Two methods of reinforcing are used to counteract this cracking tendency. In the first one, a portion of the reinforcing members at the bottom of the beam are bent up, running through the concrete at an angle varying from 30 to 45 degrees to the top of the beam and thence horizontally to the end, as shown in Figure 1.

In the second system, vertical stirrups, consisting of a series of vertical rods fastened to the main horizontal reinforcing members, and running up through the beam carry the shear. (This last arrangement is shown in Figure 2, which is a cross sectional view). Since the tendency to crack



is greater towards the ends of the girder than at the centre, the number of stirrups is increased approaching the ends. The method of reinforcing which is used and recommended by the commission consists of a combination of these two methods, using both the bent up rods and stirrups.

Figure No. 3 is a cross section through the body of a reinforced concrete abutment. The darkened portion above the abutment represents the superstructure which re[illegible] the abutment. If an expansion joint between this abutment and the superstructure is constructed to permit free movement between them, the action of the earth pressure has a tendency to produce cracks extending from the back of the abutment toward the face and should be reinforced as shown in this sketch by vertical bars placed near the back face (marked A). Should the expansion joint prove defective, the pressure of the earth under this condition produces a bulging action of the abutment and the necessity for reinforcing steel on the front face is at once apparent.



The various types of concrete highway bridges constructed in this state, adapt themselves to the following classifications:—

Circular and box culverts.
Slab bridges.
Girder bridges and arches.

The girder bridges may be sub-divided into the deck and the through types. In addition, there is the steel truss with concrete floors and abutments.

Taking them up in the order named, Figure No. 4 is of the box culvert type, showing the cross section through the barrel of the culvert. The top, sides and floor of this culvert act as beams under the vertical loads, the horizontal earth pressure, and the upward foundation pressure respectively. Since in each case the load acts from the outside inward, the reinforcing is placed in each case on the inside of the wall or slab. Since there are no expansion joints, no cantilever action can take place and there is no need for reinforcing on the outside of the walls. The top slab is reinforced with bent up bars, as shown, to provide for the diagonal tension as outlined above.

Two types of footings are used in these culverts. The one marked "A," known as a float footing, consists of a heavy floor extending clear across the slab and depending for its stability on the wide distribution of the load. In the type marked "B," the footings directly underneath the walls are carried down to a considerable depth and are connected by a thin floor slab built just strong enough to take the bending due to frost action.

The second type, as the name implies, consists of a slab or beam of concrete (Fig. 1) as wide as is required for the roadway, resting on two abutments. The reinforcing is for simple bending and diagonal tension. Since at each bridge seat there is an expansion joint, the abutments (Fig. 3) are reinforced near both back and front surface with rods running vertically and horizontally. The horizontal rods form a frame-work for the reinforcing, bond the wings to the abutment proper and prevent cracking due to temperature changes in the concrete. The rods in the back face take all the ordinary stress. The front reinforcement is called into action only in case of the failure of the expansion joint to act properly, on this account the vertical reinforcing system in the back is much heavier. Steel bars placed both longitudinally and transversely in the footing, as shown, help to distribute the footing load and to anchor the main reinforcing members.

Fig. 2 is a cross section of a deck girder bridge. The girders are nearly rectangular in section, having a slight

* From a report by Thos. H. MacDonald and C. B. McCullough, of the Iowa Highway Commission.

draw towards the bottom to admit of easy removal of the forms. These girders, or stems, are thoroughly bonded by means of stirrup rods to the floor slab which rests on top of it, the latter acting both as the floor and as a top flange for the girder. The load is carried by the floor to the girders and by the girders directly to the abutments. The rectangular sections at the side of the roadway serve simply as hand rails and do not help to transmit the load.

Due to the diagonal tension, there is always a tendency for the bent up reinforcing members to fail by a pulling out or breaking of the bond near the end. For this reason a positive connection or fastening of the main reinforcing members at the end of the girder is very desirable. A system of this kind employed with success by the commission during the last year is substantially as follows:—

The reinforcing bars are bent in the shops and fitted with a hook on the end. An end plate is also made in the shops and fitted with notches or slits from both top and bottom of sufficient width to admit the reinforcing bars. These notches are so spaced that when the reinforcing bars are dropped in they occupy the position as computed in the structure. After the bars are dropped in these notches, two small plates about 3/8 of an inch thick are bolted one to each side of the plate both top and bottom, thus completely enclosing and rigidly fastening the reinforcing members.

The other type of a girder (the through, Fig. 5) differs from the type just described, in that the girders, two in number, are placed above and at the side of the roadway. The reinforcing in these girders differs very little in principle from that employed on deck girders. The girders now occupy the space occupied by the hand rail in the deck type and the floor system is hung between the two girders and reinforced transversely in much the same manner as an ordinary slab.

In the last type, the arch, the loading comes upon the structure through the fill above it, produces cross bending in the arch ring and a thrust against the abutments. The type of abutment used commonly is known as the gravity type and consists of heavy mass concrete work depending for its stability on its size and weight. The necessity for immovable abutments will be evident from the following consideration. Any spreading or settling of the abutments will be followed by a downward deflection of the arch ring which in turn produces a tendency to crack at the crown on the lower side and at points near the spring line on the upper side. Any slight settlement of the abutments produces a tremendous stress in the arch ring and the necessity for adequate abutments cannot be too greatly emphasized.

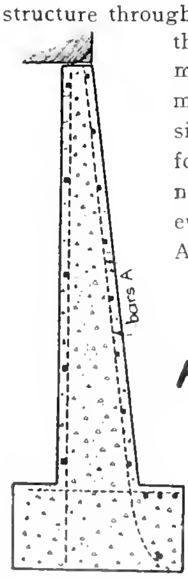


Fig. 3

The circular mold culvert is a combination of the arch and box culvert type and is adapted to small culvert work where an opening not to exceed thirty or thirty-six inches is required.

There is a distinct difference in the shape and size of the drainage lines over this state, those lying within each distinct glacial area being peculiar to that area and the types of waterways built should be selected with reference to the topography. For illustration: In the broad, flat, monotonous stretches of the Wisconsin glacial region which lies in the north central part of the state, the drainage areas are for the most part, flat and not well defined. The channels quickly fill to overflowing and a large percentage of the waterway must be obtained by raising the road grade above the land level.

For such openings, the slab and through girder bridges offer the greatest amount of waterway with the least rise and span. In the construction of bridges in this area, the possibility of the ditch being incorporated in a drainage district must always be guarded against in planning a bridge. An instance is brought to mind of a practically new concrete bridge in Buena Vista county that is to be destroyed because the foundations were not carried sufficiently deep when constructed to provide against the deepening of the channel as part of a drainage district.

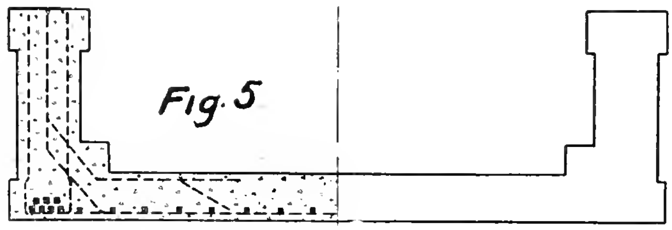


Fig. 5

In the more rolling areas along the rivers on the east and west boundaries of the state, many of the streams have deep, sharply defined channels. During times of heavy storms the water rushes through the openings in mad little torrents that quickly scour under the foundations unless they are protected by deep footings and floors. For these deeper ravines, the box culvert with ample floors and footings, the slab or deck girder or arch bridge with high rise are all applicable. In the Kansas drift area which covers a large portion of the southern part of the state, the deep cut drainage channels generally exist and these types are all applicable to this section.

For spans up to about sixteen feet it probably makes very little difference in the amount of material either of steel or concrete, required to build a culvert of either the above types provided the depth of foundation and area of waterway is the same. For spans sixteen feet and above, the character of the foundation will have much to do with the determination of the economical structure. Yellow or blue clay is about the best foundation (unless piling is used) that can be found in a majority of the counties of the state and one of these can be reached at a depth of three or four feet below the stream bed.

On such foundations the form of construction, such as the slab or girder bridge, or for the longer spans, steel bridges with concrete floors, seems to be desirable as the expansion joint at each abutment will take care of the expansion and contraction of the structure as well as any settlement of the foundation without causing material cracks.

GREAT WATERWAYS UNION.

A general meeting of the Great Waterways Union will take place at Berlin, Ont., at an early date and representatives of the many municipalities interested in the Welland Canal and St. Lawrence River route development are expected to be present. Henry Holgate, of Montreal, has been advocating on the behalf of the union that the government create a Department of Inland Waterways to study and develop inland navigation.

STORM WATER DISCHARGE.

By R. O. Wynne-Roberts* and T. Brockmann.†

(Continued from last week).

Mr. Symons, in 1878, observed a precipitation in Camden Town, London, England, falling at the rate of 12 inches per hour, continuing for 30 seconds (Moore). In the Central States of America a rate of 3.7 inches for 10 minutes, 2.8 inches for 20 minutes, 2.3 inches for 30 minutes and 1.7 inches for 60 minutes may be expected (Folwell).

The following are a few recorded examples of the intensity of rainfall. Those recorded in Toronto were kindly supplied by Prof. Stupart, the director of the meteorological service.

Year.	Place.	Duration of storm in minutes.	Actual rainfall recorded inches.	Rate of rainfall inches per hour.
1905	Ponders End, England..	19	1.05	3.32
1905	Birmingham, England .	27	1.04	2.31
1905	Birmingham, England .	7½	0.56	4.50
1906	Burnham, England	40	1.73	2.60
1906	Guildford, England	8	0.87	6.68
1907	Worcester, England	8	0.43	3.22
1905	Wallington, England ...	65	2.77	2.55
1869-1891	New York, U.S. ...	10	1.20	7.20
1871-1891	Washington, D.C...	5	0.80	9.60
1905	Washington, D.C.	78	3.11	2.38
1884-1891	Philadelphia, Pa. ..	20	1.60	4.80
	Brooklyn, N.Y.	25	2.60	6.24
1899	Frankfort, Germany	6	0.40	4.00
1899	Frankfort, Germany ...	4	0.267	4.00
1891	Frankfort, Germany ...	6	0.47	4.70
1890	Frankfort, Germany ...	7	0.55	4.70
1903	Toronto, Ontario	5	0.11	1.32
1903	Toronto, Ontario	15	0.60	2.40
1903	Toronto, Ontario	5	0.40	4 80
1904	Toronto, Ontario	7	0.28	2.40
1904	Toronto, Ontario	10	0.51	3.06
1904	Toronto, Ontario	8	0.48	4.80
1905	Toronto, Ontario	5	0.22	2.64
1905	Toronto, Ontario	5	0.25	3.00
1905	Toronto, Ontario	5	0.38	4.56
1907	Toronto, Ontario	5	0.25	3.00
1911	Toronto, Ontario	7	0.54	4.63
1912	Toronto, Ontario	5	0.25	3.00
1912	Almasippi, Manitoba ...	90	0.73	0.50
1912	Crescent Lake, Sask....	30	0.48	0.96
1912	Bardo, Alta.	60	1.20	1.20
1912	Delia, Alta.	45	1.20	1.60
1878	Chicago, Ill.	7	0.97	8.30

It is unfortunate that there is comparatively little information available as to the intensity of rainfall in different parts of various countries. Still, the records suffice to show that the maximum intensity ordinarily lasts only for a few minutes, sometimes at the commencement of a storm, other times in the middle or at the end of it. Furthermore, the area of maximum intensity is usually circumscribed and often located in different parts of a district.

It often occurs that after a prolonged drought, rainfalls of great intensity are experienced. Sometimes it happens that during long periods of wet weather, when the surface is already saturated and the sewers are flowing practically full, a rainfall of greater intensity will fall and thus give rise to floods—unless the sewers are of more than ordinary capacity.

* Consulting Engineer, Regina.

† Civil Engineer, Regina.

If records of rainfall in wet districts are carefully [illegible]d. [illegible]t will doubtless be found that the intensity is relatively lo[illegible] there in comparison with drier districts.

Figure 1 shows two curves illustrating rainfall intensity. Curve I. represents moderate amounts of rainfall observed at Edgebaston, Birmingham, England. This curve is a copy of one prepared by Mr. Wallington Butt, who stated that it is more or less applicable to other parts of England, and by it storm water discharges can be estimated in that country. Curve II. represents the mean highest rainfalls observed in Germany, and this generally constitutes the maximum intensity assumed in that country.

Both curves serve to show that the intensity of a rainfall varies inversely with the duration of the storm. For example, a rainfall of 20 minutes duration has an equivalent intensity of one cubic foot per second-acre in Birmingham, and 1.73 cubic feet per second-acre in Germany, whilst a ten minutes rainfall has an intensity of 1.33 and 2.36 cubic feet per second-acre respectively.

Although the following diagram (Fig. 1) will be found useful as a graphical method of ascertaining the factor of rainfall intensity with sufficient accuracy, it will doubtless be acknowledged that it is highly desirable to ascertain the intensity in any particular district by means of reliable automatic recording rain gauges, of which the simplest is usually the best.

In countries where a considerable accumulation of snow takes place, such as in Canada, and this melts in spring time, it is a matter of great importance to give this point careful thought, for it often occurs that rain falls when the temperature rises, and this causes serious floods. No statistics are at present available on this feature of our enquiry, so it must be left for the reader to bear it in mind when undertaking investigations.

In addition to ascertaining the rainfall intensity in any district, it is practically certain that it will not be of uniform intensity throughout that area, especially if the area is at all extensive. An interesting example of this is referred to by Sir Maurice Fitzmaurice, who, when discussing Mr. Lloyd Davies' paper, remarked that very heavy showers were extremely local in character, and mentioned a case where rain falling heavily at Hampstead caused a sewer at King's Cross, London, to be gorged and some lives to be lost, although, where the men were working no rain had fallen. The distance between the two places is only about three miles.

Careful observations have been made, in Germany, for instance, and it was found that the mean intensity of rainfall became less as the drainage area increased in size, or the sewers increased in length, beyond a certain radius from the point of heavy rainfall.

It may be stated that observations were made in Breslau, Germany, on an area of about 1,700 acres to ascertain the relative intensity at three stations located as far apart as possible, and it was found that during a period of 760 minutes rain fell simultaneously for only 90 minutes at two stations, and at the three stations for only 28 minutes. In view of these facts, it was not justifiable to assume a uniform intensity over a large area. Further investigations were, therefore, instituted so as to ascertain in what manner the maximum intensity "qr" varied, with the result that it was found that the intensity diminished to "qr/2" in a distance of about 10,000 feet from the point of observation.

It may be objected that it is too unfavorable to base a conclusion on such limited number of instances where rain fell on all three or two stations as the same time, and to ignore the larger number of rainfalls which occurred at solitary stations.

It is submitted, however, that such precaution is justified by the limited extent of the observations, by their local char-

acter, and by the fact that storms are not stationary, but travel in different directions, sometimes across a district, sometimes diagonally and at other times along the major axis of the drainage area, in the latter case a proportionately

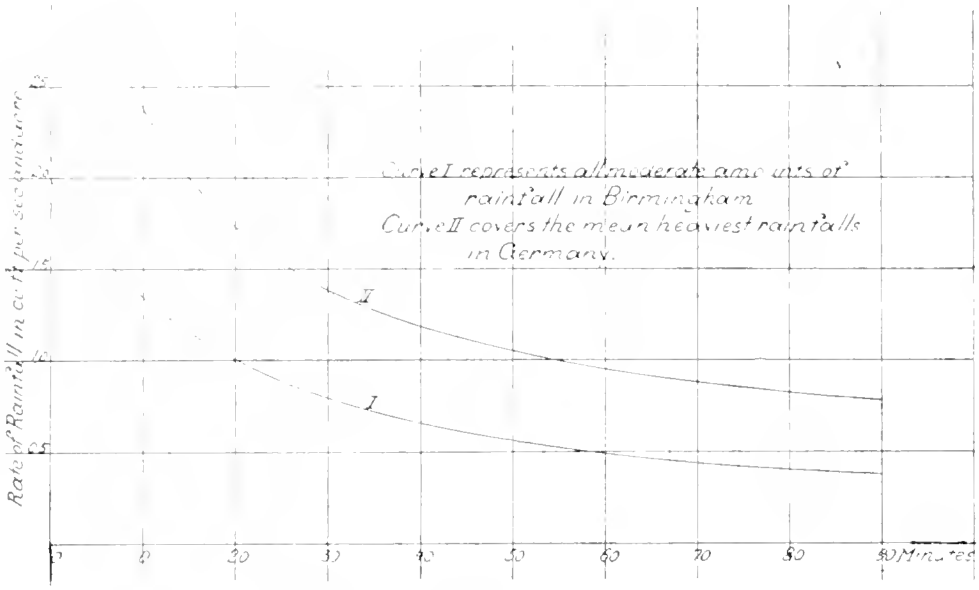


Fig. 1.—Rainfall Intensity Curves.

larger quantity of storm water will naturally have been precipitated and have to be dealt with.

It may also be contended that it would be more accurate to take, instead of the length of 10,000 feet, a value depending directly on the intensity, for as the area decreases, the intensity increases. The results of the observations, however, are not sufficient to ascertain, with any degree of accuracy, the relation which subsists between the intensity of a rainfall and the area and, moreover, those downpours taken into consideration have some features in common in the manner of occurrence, and do not differ very much in their intensity.

For the sake of simplicity, it may be assumed that the curve representing the decrease from the maximum intensity "q_r," to that at the remote part of a district, "q /2," is that of a parabola, so that the intensity and extent of any storm are represented by a solid of revolution, generated by the revolution of a parabola along its axis, and a section along this axis will therefore be, as shown in Figure 2, at M, A, N, O, P, being limited on the top by two parabolas. The ratio between the solid of revolution and a cylinder representing a uniform rainfall, then, will give the coefficient

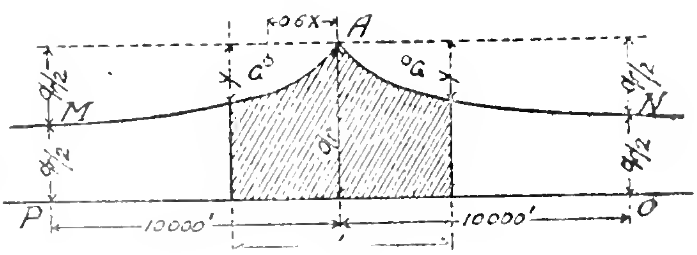


Fig. 2.

"I" by which the highest intensity assumed has to be multiplied so as to obtain the average intensity of storm, and his factor is called the "coefficient of intensity."

Let "A" be the zero point, then the parameter "p" is found from $10{,}000 \times p = \left(\frac{q}{2}\right)^2$ or "p" equals $\frac{q^2}{40{,}000}$; the equation of the parabola will be

$$\text{"}y^2\text{"} = \frac{q^2 \times x}{40{,}000}.$$

The circumference described by the centre of gravity in revolving is $2 \times 0.6\, x \times \overline{x}$, therefore the content of the solid of revolution corresponding to the shaded area (cylinder minus parabola) is

$$x^2 \pi q - \tfrac{2}{3}\, x\, y\ 1.2\, x\, \pi = x^2 \pi (q_1 - 0.8\, y)$$

and

$$\text{"I"} = \frac{x^2 \pi (q_r - 0.8\, y)}{x^2 \pi q_r} = 1 - 0.8\,\frac{y}{q_r}.$$

As $\frac{y}{q_r} = \sqrt{\frac{x}{40{,}000}}$, "I" $= 1 - \frac{0.8\sqrt{x}}{\sqrt{40{,}000}}$.

The downpour will yield the maximum storm if "A" is located in the centre of the drainage area, and then "x" may be assumed to be equal to one-half of the length of the sewer and it will be:—

$$I = 1 - .0028\sqrt{L}$$

"L" is the length of the sewer in feet.

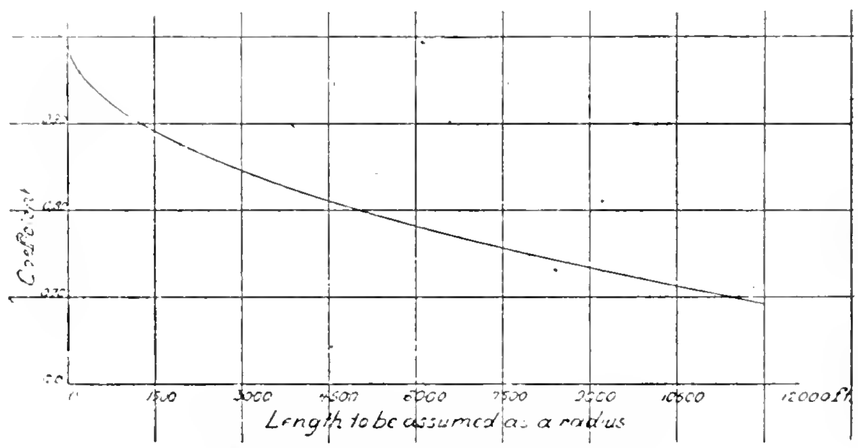


Fig. 3.—Diagram for Determining the Coefficient of Intensity.

If "q_r" be taken equal to "y" then from the equation of the parabola, the values "x" equals 40,000 feet and "L" equal to 2x equal to 80,000 feet will be obtained. This, therefore, is the limit of the application of the above equation and obviously this limit will accordingly not be attained even in the case of very extended sewerage system.

The following table will give the coefficients of intensity ascertained by means of the foregoing formula $I = 1 - 0.002\sqrt{L}$:

L in feet.	Coefficiency of intensity.	L in feet.	Coefficiency of intensity.
500	.937	5,000	.802
750	.923	5,500	.793
1,100	.9115	6,000	.782
1,250	.900	7,000	.766
1,500	.892	7,500	.758
1,750	.883	8,000	.750
2,000	.875	9,000	.733

L in feet.	Coefficiency of intensity.	L in feet.	Coefficiency of intensity.
2,500	.860	10,000	.720
3,000	.847	12,000	.692
3,500	.835	15,000	.660
4,000	.823	20,000	.605
4,500	.813		

Figure 3 has been prepared to give the above information.

As an explanation of the foregoing table and diagram, it may be stated that if the calculations in connection with a proposed sewerage system is based upon a high rainfall intensity of, say, 1.428 cubic feet per second-acre, the sewer being, say, 1,650 feet long, the coefficient for which in the above table and diagram is 0.89. Then 1.428 × 0.89 equals 1.271 cubic feet per second-acre, which is the intensity to be provided for when designing the sewers.

It will be observed that it is necessary in this connection to reduce the rainfall, which is measured in inches depth, to cubic feet per second-acre. As one inch of rain per hour on one acre is practically equal to one cubic foot per second-acre, it will be a simple matter to make the conversion. Thus

1 inch of rain per hour equals 1 cu. ft. per second-acre
0.5 inch of rain per hour equals 0.5 cu. ft. per second-acre
0.1 inch of rain per hour equals 0.1 cu. ft. per second-acre
and so on.

(To be continued).

JANUARY PRECIPITATION.

Precipitation was deficient from Eastern Saskatchewan to the Highlands of Ontario, throughout the Maritime Provinces, with the exception of the vicinity of Halifax, and also over the southern part of Vancouver Island. Elsewhere the amount recorded exceeded the average. The snowfall in British Columbia was phenomenal, especially in the Coast districts. At Vancouver nearly five feet of snow fell during the month and sleighing was general for three weeks.

A considerable quantity of snow fell in British Columbia during the month, and at its close sleighing was good in most localities, the depth in southern districts being about eight inches and in the north, five feet. In Southern Alberta the snow covering slightly exceeded one inch, but elsewhere in the Western Provinces the depth was generally more than six inches, and reached twenty-five in northern parts of Manitoba. Much less snow than usual was on the ground from Ontario eastwards, there being about thirty inches in northern districts which decreased as southern localities were approached, where in Ontario and the Maritime Provinces the ground was bare of snow.

The following table, included in the report of the Meteorological Office, Toronto, shows the total precipitation of fourteen stations for January, 1913:

	Depth in inches.	Departure from the average of twenty years
Calgary, Alta.	1.32	+0.86
Edmonton, Alta.	2.40	+1.69
Swift Current, Sask.	0.50	—0.16
Winnipeg, Man.	0.80	—0.17
Port Stanley, Ont.	5.70	+2.37
Toronto, Ont.	4.36	+1.55
Ottawa, Ont.	4.10	+1.11
Kingston, Ont.	4.90	+2.03
Montreal, Que.	5.10	+1.35
Quebec, Que.	3.70	+0.50
Chatham, N.B.	3.40	—0.18
Halifax, N.S.	6.30	+0.45
Victoria, B.C.	4.50	—0.04
Kamloops, B.C.	3.10	+2.15

FACTS AND FANCIES ABOUT SEWAGE DISPOSAL.*

By Gilbert Thomson, M.A., F.R.S.E., M.Inst.C.E.

The number of methods of dealing with sewage has been enormous. They may be broadly grouped into four divisions:—

No treatment.
Land treatment.
Chemical treatment.
Bacterial treatment.

These are not necessarily distinct, as more than one may occur in the one installation. But the four divisions are convenient.

The no treatment system is of very limited application. It has been ousted in succession from small streams, from large streams, and from tidal rivers. It has a rather precarious hold even on the sea, except where a specially suitable place of discharge can be found In our limited time we may with advantage confine our consideration to those methods of sewage disposal which involve more or less of treatment.

I might begin by referring to one or two popular fancies. One is that filtered sewage is good drinking water. It is not. A sewage effluent may be very good as a sewage effluent, and very bad as drinking water. Good drinking water should be free from any trace of sewage contamination; a good effluent is one from which the polluting matter has been partly removed, and in which the remainder has been rendered harmless. The analytical results which indicate the most satisfactory sewage effluent would utterly condemn the water for drinking purposes. There are many good effluents, many indifferent ones, and I fear still more bad ones, but I would decline the invitation to drink even the best.

Another popular fancy is that there is a "best" system of sewage disposal. It is quite natural that an inventor or patentee should think that his particular system is the best. We give him credit for perfect good faith even when he tries to convince us that it is equally applicable to works draining a populous area of many square miles, requiring inlet sewers in which men walk upright, where there is an equipment of elaborate machinery, where the tanks have to be in a more or less populous neighborhood and of great size, and where the discharge is into a large tidal river like the Clyde—the illustrations are from the Glasgow works—and to a work of modest dimensions, with no machinery, discharging into an inland stream. We take the liberty of thinking, however, that his opinion is prejudiced.

Even when a man is not an inventor, if his experience has been limited to a few examples, he is very likely to draw rash conclusions, and to assume that because he has seen one system doing better than another the relative result will always be the same. In doing so he forgets two things—first, the suitability for local conditions; and, second, the personal element.

In speaking of the personal element, I do not refer chiefly to those who are responsible for the design and supervision of the construction, nor to our useful, if somewhat rough, friends who actually carry it out; but I refer especially to the men who, day in and day out, with sometimes little recognition of their care and ability, keep the works in proper order. I should like to repeat what I have often said before, that the efficiency of any sewage work, whether it is a big one like Glasgow or Birmingham (from both of which we have illustrations), or a work too small to require the

*Abstract of lecture before the Sanitary Association of Scotland, September 18th, 1912.

whole attention of one man, depends quite as much on its management as on its construction.

One of the most interesting duties in connection with sewage is to be called in, as a doctor is called in, because the works are "sick." Without touching on the highly controversial subject of medical men and contract practice, I am strongly of opinion that something of this nature might be useful in sewage works. The big work has its own skilled man, but the little work has to call in the doctor when its digestion goes out of order, and, like the human patient, it is apt to be pretty bad before the doctor, in the shape of the engineer, is called in. Much unpleasantness might be saved by a regular visit, and the administration of the necessary tonic before the patient's condition became serious.

It might be of interest to mention some of the common ailments:—

Overwork is the most common of all. This may either be general overwork, due to the deficient size of the installation; or local overwork, due to the bad distribution of the work, in other words, of the sewage. This last is very common.

Faulty tanks, allowing too much suspended matter to reach the filter.

Filters clogged and requiring to be re-made.

Improper drainage of filters.

Some mechanism out of order.

These points will be better appreciated after some consideration of the various methods. The remedy, of course, depends on the exact nature of the trouble.

Of all the methods of treating sewage, it is probably correct to say that none has surpassed land treatment in producing a good effluent. It is not many years since (in England) it was compulsory to finish off with land, whatever the preliminary treatment may have been; and the general abandonment of land in recent years has not been because of its inefficiency, but on account of other difficulties, chiefly that of getting enough land. No further back than last month I heard at the York Congress of the Royal Sanitary Institute a strong plea for land treatment, and, although some of the arguments in its favor were far from convincing, it must not be supposed that this treatment is altogether out of date. The stock argument, that it is a more "natural" process, reminded me of the reasoning of Mause Headrigg in "Old Mortality." She objected to her son being called on to use fanners for winnowing corn, "instead of waiting patiently for whatever dispensation of wind Providence was pleased to send."

Natural or not, land treatment may give excellent results; but when one bears in mind that under the system of broad irrigation, from which alone good farming results are to be expected, an acre will not serve for a population of more than 100, and that with the most concentrated system of land filtration an acre of actual filter is needed for every thousand of the population, it is easy to see why processes which do the work on a very much smaller area are usually preferred. It is simply out of the question in the case of a large town to obtain a sufficient area of suitable land; even a small town finds it difficult. An artificial filter will deal with a population of many thousands per acre.

Almost every form of treatment begins with rough screening, which removes such things as dead cats and old boots, and which in a large work results in a great volume of refuse. This is usually combined with a settling tank for the rougher grit. In Glasgow this is taken out of the tank by a dredger.

In land treatment there is no other preliminary, but the chemical and bacterial methods of treatment have preliminaries which are vital parts of the process.

Before speaking of chemical and bacterial methods, it is desirable to refer to the composition of sewage from a mechanical point of view.

Sewage consists of water, with polluting material partly dissolved and partly suspended.

The scum is of little consequence. Most of it ultimately disintegrates and either dissolves or sinks. The sludge is a very different matter.

It has certain manurial value, but with about 10 per cent. of manure you have about 90 per cent. of water. It does not pay, therefore, to carry it far, and in the immediate neighborhood of a large town the demand for manure is limited. It is possible to get rid of some of the water by allowing the sludge to settle in large tanks, as is done in the Glasgow works at Dalmuir and Shieldhall. Still more can be got out by drainage on filters, as is well illustrated by a series of views from Birmingham. A still further advance is made by filter-pressing, as is done at Glasgow Dalmarnock works. And, finally, at the same works a valuable and compact manure is produced by further drying the filter-pressed sludge. But raw sludge is of so little value that where water transport is readily available, as at Dalmuir and Shieldhall, the method which is adopted is that of taking the sludge out to sea and depositing it in deep water.

Leaving for a time the question of filtration, let us look at the bacterial process. Their war-cry for a time was "No sludge," but that, I think, has been dropped or modified.

Everybody has heard of the septic tank. When I had the honor of addressing this congress from the chair in 1898, I described a pilgrimage which I had made a year or two earlier to Exeter to see what was then the last word in sewage purification, and which was hailed as a complete solution of the sewage problem. It has certainly been of great value, but the septic tank is in itself no solution of the sewage problem. The Royal Commission has reported adversely on some of its chief claims.

The name took the public fancy. It became familiar to many who knew little about sewage, and the microbes who inhabit these tanks have become familiar friends. Many people seem to be on fairly intimate terms with them, and to know that their chief occupation is that of eating each other up. I have been gravely assured that this process of mutual consumption can be watched, and I have heard an emphatic condemnation of a tank on the ground that no microbes could be seen in it. Thousands of people who know nothing whatever about sewage purification will tell you, without the slightest hesitation, that the proper way to purify sewage is by means of a septic tank. They sometimes spell it "sceptic," which describes exactly the proper mental attitude to such a proposal. It is no exaggeration to say that nowadays one of the difficulties in dealing with sewage is to convince those concerned that anything more is needed than to construct a big cesspool, and to call it a septic tank.

It is quite true that the early septic tanks wrought for years with no great increase in the material deposited in the bottom, and it was not unnatural to conclude that most of the solids were dissolved. But experience has shown that when accumulation of sludge does not occur in the tanks, it simply means that the fine suspended matter is passing away in the tank liquor. Unfortunately, many tanks have been constructed with no convenient arrangement for removing sludge, in the belief that no sludge would be produced. This is one of the fancies for which local authorities have had to pay dearly. What happens is that, after a certain amount of accumulation has taken place, the liquid leaves the tank heavily charged with matters in suspension.

So far we have dealt with what may be called the early history of sewage disposal. This brings us to a compara-

tively new field of inquiry. The liquid which leaves the tanks, and which is now usually termed "tank liquor," contains always a large proportion of matter in solution, and usually a quantity of matter in suspension. With the former it is quite easy to deal. We can't remove it, but by proper appliances it can be oxidized and rendered harmless.

The required method is filtration. If the sewage is passed through a proper filter, to which the oxygen of the air has free access either periodically or all the time, the filter, like the tank, will soon swarm with minute life. This life is instrumental in bringing the sewage matters and the oxygen into intimate contact, so that the sewage matters are burnt up by the oxygen.

In order to have this done effectively, it is essential that the sewage be divided into the smallest possible parts, so that the microbes may come into contact with all of it. This division may be effected in various ways—the liquor, for example, may be sprinkled on the top of a filter, or it may be poured on in bulk and allowed to find its way through the interstices of the material—but somewhere and somehow it has to get through small openings. If the liquor contains only dissolved matter, it will pass freely through these small openings; if it contains suspended matter, it will soon choke them up.

The importance of this is not realized as it ought to be. It is good policy to spend money and trouble in getting a tank liquor which is reasonably free from suspended matter.

It is much cheaper to clean a tank than to clean a filter, even when the tank has not been well designed for the purpose; while with a well-designed tank there is no comparison. This is a branch of sewage engineering to which far too little attention has been given.

I do not mean that it has been ignored by those who are really experts; but in ordinary works the design of the tanks is usually the weakest part. Even in works of considerable size, the tanks too often show evidences of the belief that the sludge will disappear, and that no provision for its removal is required.

On the other hand, some very ingenious systems have been devised, with the object of getting the solid matters out of the main stream of sewage. There are three tanks of which a good deal is heard—Dr. Travis's hydrolytic tank, the Imhoff tank, and the Dortmund tank. Of the two former I will only say that in them the sludge which settles out from the sewage is encouraged to pass through openings in the bottom of the channel into a part of the tank where there is little or no flow. With the long and comparatively narrow tank common a few years ago, the sludge might settle down, but it could not get out of the current. Everybody is familiar with the manner in which a person may be swept along by a crowd in a narrow passage; he may be most unwilling to go on, but he has no choice. But if there are side passages or recesses here and there, the person who wishes to stay behind gets into one of these. Much the same principle applies in these tanks. They are somewhat complicated in construction, and the question of whether or not it is worth while to use them must be settled for each individual case.

The Dortmund tank is better known. It was first employed at the town of Dortmund, whence its name. For a while it had no great popularity, but it is now very often used. In principle it is little more than a deep pit with sloping sides, down which the sewage matters fall, while the liquid passes over the top.

But supposing the sludge to be satisfactorily caught in such a pit, how is it to be got out? It would be a very troublesome operation, and a very offensive one to empty the tank every now and then to get out the sludge. If you make a hole in the side of a tank full of sewage the sewage will run out, or if the hole is made into the part which is filled with sludge, it is the sludge that will come. If you provide a pipe dipping down into the sludge, and coming out below the surface level, the sludge will come out near the surface level; and if you provide the pipe with a valve, it is quite easy to wait until the sludge has gathered, open the valve, and let the sludge run out, and shut the valve whenever the sludge has been removed. By such an arrangement it is easy to remove the sludge as often as may be necessary without disturbing the tank to any extent, and therefore with comparatively little smell. It is well to say comparatively, for there are few operations connected with sewage that don't smell more or less, and it is of the utmost importance to have as little handling of it as possible. Various methods of dealing with the sludge after it has been got out have already been mentioned. Another method which has recently been devised is to spread in a special tank a layer of stable litter, then run in a layer of sludge, spread another layer of stable litter, and so on. The great point is to get the sludge as free from water as possible, so that it may become fairly portable, and thus available as manure. The liquid which drains from it is, of course, very foul, and unless it can be properly filtered in some other way it is pumped back into the tank among the sewage. Fortunately, there is not very much of it.

There is no time to do more than mention "slate beds," where the sewage enters not a large unoccupied space, but a space provided with numerous slate shelves, so that the deposited matters may be more fully disintegrated.

We may now return to the liquid which leaves the tank, whether the tank is a precipitation tank, a septic tank, or a sedimentation tank. It is no longer crude sewage, but what is known as "tank liquor." It is very far from being pure water, and has still to be filtered.

Here our friends the microbes have their second innings, and, with all respect to the anaerobic branch of their family, most sanitarians are agreed that the aerobic microbes are more to be trusted. We have got out of the sewage everything that we can by a rough process of settlement, aided by any breaking up or dissolving that may take place. The tank liquor is tolerably clear—if our tanks have done what they should—but it is full of putrescible matter, dissolved if not suspended. We want to get this putrescible matter oxidized, and so rendered harmless.

We do this by getting it into close contact with pieces of filtering material, swarming with bacteria, and see that these bacteria are liberally supplied with oxygen, that is to say, with fresh air. This close contact is not so easily got.

Two methods have been adopted. The one is what is known as the "contact bed," the other as the "percolating" or "streaming" or "continuous" filter.

The contact bed consists of a big tank, usually about 3 or 4 feet deep. It is filled with the "filtering medium"—usually clinker or some such material broken into pieces about the size of road metal. Many materials have been used, and many different sizes have been tried.

Of course, there is still a good deal of space left between these pieces, and into this space the sewage is run. Roughly speaking, the filtering material occupies about two-thirds of the total space, and the liquid about one-third. By this means of working there is no question that the sewage must be brought into close contact with the filtering material. Suppose the filtering material to be covered with a multitude of microbes, each fed up with fresh air and hungry for sewage, it follows that when the sewage is let into the bed these microbes promptly set to work. After a while, however, they become fed up with sewage, and want more fresh air, not to speak of time for digestion. The liquid, therefore, must be run out of the bed to let the fresh air in. The whole process

is an intermittent one, and consists of four stages—filling, standing full, emptying, standing empty. It follows that there must be more than one bed, so that at all times one may be filling. Very often the number is considerable; five is a convenient number, so that one may be in each of the four stages, and one taking a rest.

The original septic tank installation was of this type. A most ingenious set of tilting buckets was employed, so that all the changes were wrought automatically. When a bed was full the flow of sewage was turned on to the next. When it had stood full for a certain time it was allowed to empty, all by these automatic contrivances. Since then many other methods have been devised for controlling the operations, most of them depending on syphon action.

This method of filtering sewage has fallen on evil days. The Royal Commission has issued a report which is not very favorable to it, and in the future it is probable that contact beds will be the exception. The report showed that, when original cost and running expenses are both taken into account, contact beds are not such an economical method of dealing with sewage as are percolating filters. It must not be forgotten, however, that they have certain advantages, not the least being that they are much less likely to cause offensive smells than some other methods. But any method of sewage disposal is ready to cause smell on very slight provocation.

The other method is to sprinkle the tank liquor on the top of the filter like a shower of rain, or like a dose from a watering can. At first sight it might appear that nothing is easier than to water the surface of a filter with fair uniformity, giving each part an equal share of the liquid. In fact, it is far from easy, and of the failures which have occurred in sewage purification a big proportion may be traced to failure in this particular.

Look at the matter in this light—In designing a sewage filter, the first thing to be considered is the amount of work it has to do. Having ascertained this as nearly as he can, with, of course, a proper provision for uncertainty and for future extension, the engineer calculates what size of filter will be needed, and the filter is constructed of a capacity to fit the work to be done. A well-designed system is based on each part of the filter doing its proper share of the work. But if the distribution is so bad that one part of the filter does no work or far too little, it follows that the other parts get more than their share to do. Some filters have been designed rather extravagantly, and are too big for their work, in which case bad distribution may not cause any visible harm. But if the filter has been well proportioned, bad distribution soon results in bad effluent and offensive smells. A sewage filter which is working well has no serious smell; but a filter which has been overwrought, and has become "sewage sick," takes a prominent place among nuisance producers. It is very false economy to have bad distribution; it must be paid for either in extra size of filter or in nuisance.

In big works, where power-driven appliances are in use, it is quite common to use power to drive the distributors. In that case it is fairly easy to get good distribution, and, besides, in such a place there is skilled attendance to put right at once anything that may go out of order. There is little doubt but that the best results which have been attained have been under these conditions.

But in small works the sewage has to distribute itself, the power being derived from its own fall. More than that, the fall that can be given is usually very limited, and many inventors have been at work on the problem of how to distribute the liquid which comes from the tank, keeping in view that the surface level of the filter should be as nearly as possible the same as the level of the sewage in the tanks. It often happens that between the sewage level in the tanks and the level of the bottom of the filters there is nothing to spare, and any fall required to distribute the liquid must simply mean a reduced depth of filter.

Much ingenuity has been displayed in meeting this requirement, and a number of prominent methods will be illustrated. They may first be classified as follows:—

1. Distributors which are fixed.
2. Distributors which move.

The first class contains the following:—

(a) A gridiron of perforated pipes.—This is not often used on a large scale, being apt to choke up, and also being irregular in its distribution.

(b) Trays.—These have the advantage of not requiring much fall, but it is difficult to maintain even distribution. The large surface of exposed liquor adds materially to the risk of nuisance from smell, while the trays hinder the free access of light and air. Installations of this type are very common.

(c) Sprays.—These are only available when there is plenty of fall. In favorable circumstances they are the cheapest of satisfactory distributors.

They have been adopted as the standard type at the Birmingham filters, probably the largest in the kingdom. In Scotland the Crieff sewage is distributed by these sprays with very satisfactory results. Many varieties of jet have been tried, the object being to secure freedom from choking, and at the same time to throw the spray horizontally over the bed and not to send it much into the air. Otherwise the risk of smell is considerable. The jet shown was a great improvement on the earlier types.

Of the second, the following are in common use:—

(a) Revolving distributors with perforated arms.—The perforations are on one side of each arm, and the reaction causes the whole apparatus to revolve. The system is a clever adaptation of "Barker's Mill," which was otherwise little more than a scientific toy. The trouble is that the holes are necessarily small, and thus apt to choke. Various mechanical devices have been applied to the clearing of the holes, and several very ingenious systems of suspending the apparatus so as to revolve with the minimum of friction are on the market. The principle is in very common use.

(b) Revolving distributors driven by central turbine.—In order to avoid the difficulty of the small holes this method of driving has been used. The reaction of the arms is not needed for driving, and so the arms are open troughs, over the edge of which the liquor spills as they revolve.

There is a risk in either of these types that with a very small flow the revolution may stop. It is usual, therefore, to pond up the tank liquor when the flow is small, so that it is discharged not in a continuous dribble, but in a succession of rushes. These distributors, therefore, in dry weather are usually working and resting in fairly quick succession. There is nothing against this, except that the necessary syphons introduce an extra complication.

(c) Revolving distributors of the water wheel type.—These are driven by the weight of the liquor, which is delivered into the buckets by a feed pipe. The distributor is a long drum, pivoted at one end and carried by a driving wheel on a rail at the other. As the drum turns it moves along and so spills the liquor over the filter. It is a more cumbrous and costly apparatus, but does excellent work. On a large scale care has to be taken to balance it by having two arms, otherwise the wind might hinder its movement.

All the foregoing require that the filters should be circular. It sometimes happens that the ground is more suit-

able for rectangular filters, or that percolating filters are used to replace contact beds, hence the introduction of the next type.

(d) Travelling distributors of the water wheel type.—In principle these are identical with those just mentioned. The feed, however, instead of coming from the centre, is taken by a syphon from a long trough. In the most recent type the weight is carried chiefly by one central rail, a small proportion resting on the trough for balancing purposes.

Most of the methods are the subject of patents, some of them of many different patents. Each manufacturer, quite naturally and not improperly, does his best to keep his wares before the public, and the wares, as a rule, are good. The variety of apparatus, all designed to perform the same apparently simple operation, is somewhat bewildering. When a man sees an installation working well, and producing a high-class effluent, he is naturally inclined to say that the system must be a first-class one, and he is apt to conclude that he need only adopt that particular system in order to produce as good a result elsewhere. That is a dangerous fancy. It is not only the effluent that must be considered. I have in my mind two works, one producing an effluent which to appearance is spring water, and which gives analytical results which are entirely satisfactory. The other produces an effluent which shows evident signs of being other than clean water. One might say that the first works were much better than the other. But I believe that the latter works are purifying the liquid to a greater proportional extent than the former. The sewage in the one case is from a residential town, with a liberal supply of water; the sewage in the other is from a mining village, where the supply of water is very limited. When the comparison is made between the sewage entering the works and the effluent in each case, it is realized that effluent alone is not a fair test.

It is not only the distribution that affects the efficiency. The essence of filtration is that the liquid and the oxygen of the air are brought into contact. It is useless to supply the filter with liquid unless it is also supplied with air, and if the bottom of the filter gets choked either with water or with rubbish, there is no chance of air getting into the body of the filter. Accordingly, it is important to have the bottom of the filter freely supplied with channels by which the water can escape and the air enter.

Look also at the different kinds of filter wall. In some cases the filtering material is merely a bing with no contain-walls; in others there is a "dry stone dyke" to hold in the material, or there is a rough wall built of the bigger lumps of the material itself. Then, again, there is ordinary brickwork, and in other cases there is "pigeon-hole" brickwork. The idea of the open walls is to allow air to enter more freely, but the general opinion now is that if the bottom of the filter is well ventilated it matters little how the walls are constructed. The real test is economy in its broad sense, and it is rather amusing, on the one hand, to hear it argued that walls are an unnecessary extravagance, and that the material should be allowed to take its own natural slope; and on the other, that the extra material thus required and the extra land occupied would cost more than the wall. The relative cost, of course, depends largely on local conditions, but personally I would be inclined to have a wall of some sort, however rough, if it were only for the sake of keeping the place more tidy.

The subject of sewage disposal is becoming more and more complicated. At one time the choice of system was made, as it were, in the mass; the decision to adopt land treatment, chemical treatment, or septic tank treatment, covering practically all the general arrangements. Nowadays the usual thing is to adopt what may be called septic treatment, but which I much prefer to call "bacterial" treatment, as being a wider description; but the choice then [illegible] beginning. The shape and capacity of the tanks, the method of working them, the removal and subsequent disposal of sludge, the application of the liquor to the filters, the shape of the filters, their depth, the kind of material and the size of the pieces, the drainage of the filters—these are only some of the problems which have to be solved, and the solution of one does not always help in the solution of the next. Frequently the balance between different courses is extremely fine, and in many instances it would be impossible to say dogmatically that one was right and the other wrong.

There are quite a number of different systems, any of which will work quite efficiently if the details are skilfully designed and the working efficiently supervised, and it is quite possible that two equally competent men may arrive at quite different designs. The economical solution of the problem calls for two things—a thorough knowledge and clear grasp of general principles, and a thorough and detailed investigation of the special conditions of the place. The most economical system is not always that which is apparently cheapest; on the contrary, economy and cheapness are often very different things.

The difficulty is emphasized by the fact that the money to be spent is public money, and those responsible for the expenditure are very properly jealous of any unnecessary cost. Not being themselves experts, they are apt to take any promise of cheapness at its face value, forgetting that an estimate may be very reliable or very sanguine. In England, where many local authorities invited competitive schemes, and adopted what promised to be the cheapest, many cases have occurred where the final cost bore only a distant resemblance to the original estimate. The intervention of the local government board, who called pointed attention to these costly object lessons, pretty well killed that practice there, and I have sufficient faith in Scottish shrewdness to expect that the lesson will be taken here without many such experiences.

EXPANSION IN RAILWAY BUILDING.

The Canadian Northern Railway and its subsidiary companies disposed of $28,960,000 securities in 1912, or 41 per cent. of the year's total.

The Grand Trunk Railway required heavy financing during 1909, 1910 and 1911, but in 1912 issued no securities to the public. Under a special arrangement, we understand, certain advances were made to this company by the Dominion Government. The Grand Trunk Railway in 1912 issued securities aggregating $19,800,000, as compared with $10,000,000 in 1911. The issuance of equipment trust notes by the Grand Trunk Railway is worthy of special mention in that for the first time this company availed itself of this modern and reasonable method of financing its equipment requirements. These obligations found a ready market in the United States.

The Canadian Pacific Railway made its annual issue of 4 per cent. consolidated debenture stock, aggregating $10,962,320, proceeds of which were used to build branch lines, purchase additional steamships and to acquire the bonds of subsidiary companies. Its larger requirements are met by the sale of capital stock, of which $18,000,000 was issued in 1912, with an additional $60,000,000 in immediate prospect.

The construction of the Edmonton, Dunvegan and British Columbia Railway is the first serious attempt to open up that part of Northern Alberta commonly known as the Peace River country.

The aggregate production of lode gold in British Columbia up till 1912 was 3,421,000 ounces (fine) of $70,497,000. The placer gold amounted to $72,130,000, making a total of $142,636,000. The Yukon shipped out $169,000,000.

ASPHALTIC CONCRETE AND SHEET ASPHALT PAVEMENTS.*

Asphaltic Concrete Pavement.

Subgrade and Drainage—H-1.—The subgrade and drainage shall be constructed to the plans, profiles and specifications of the City Engineer.

Foundation—H-2.—The foundation upon which the pavement is to be laid shall be concrete, and shall be prepared according to specifications and requirements of the City Engineer.

Wearing Surface.—H-3.—Upon the prepared foundation shall be laid the asphaltic concrete wearing surface, consisting of a mixture of selected, hard, crushed stone, gravel and sand, mixed with asphaltic cement as hereinafter specified. The wearing surface shall be of a thickness of 2 in. after thorough compression with a roller weighing not less than 200 lbs. to the inch width of tread, and shall contain between 7 and 12 per cent. bitumen soluble in carbon disulphide, depending on the mineral aggregate treated.

Mineral Aggregate—H-4.—Stone.—The stone shall be crusher run varying in size from a maximum of ½ in. to the smallest particles retained on the finest mesh screen commonly used on crushing plants. The dust or fine screenings should be completely removed from the stone, as it is usually excessive and irregular in quantity and necessitates the use of a greater amount of asphaltic cement. Sufficient sand and filler, varying from 8 to 15 per cent., shall be added to completely close and fill the interstices of the mineral aggregate. After being rolled the surface shall present a granular appearance, showing that the structural body of the pavement is crushed stone. The asphaltic cement shall be in sufficient quantities to bind and fill the mixture as specified above, but not to flush to the surface as free cement under the roller.

Sand.—Sand shall be clean, moderately sharp and well graded, and shall be free from loam.

Mix.—The mix shall consist of a mixture of sand and stone as above specified, so as to comply with the following specifications:—

Passing 100 x 200-mesh sieve		8 to 15%
Passing 80-mesh sieve	10 to 20%	Mineral aggregate
Passing 40-mesh sieve	15 to 30%	
Passing 10-mesh sieve	30 to 40%	
Passing ¼-in. ring	15 to 40%	
Passing ½-in. ring	0 to 30%	

Method of Mixing—H-5.—The aggregate shall be thoroughly dried in properly designed driers before mixing with the bitumen. The driers shall be of the revolving type, thoroughly agitating and turning the materials during the process of drying. When the aggregate is thoroughly dried and heated to a temperature of from 200 to 350° F. (depending upon the asphaltic cement used), it shall, immediately before cooling or exposure to moisture, be mixed with the hot asphaltic cement as hereinafter specified.

The asphaltic cement shall be melted in a tank arranged so that the heat can be properly and easily regulated. When melted and raised to a temperature of from 200 to 350° F. (depending upon the asphaltic cement used), it shall be combined in proper proportions with the hot aggregate and immediately mixed in a properly designed mixer with revolving blades until a thorough and intimate mixture of the ingredients has been accomplished, and the particles composing the aggregate evenly and thoroughly coated with the asphaltic cement.

Laying—H-6.—Paving mixture at a temperature of from 200 to 350° F. shall be hauled on to the street in dump wagons, and shall be kept well covered with canvas to retain the heat, and dumped and shoveled into place. While it is still hot it shall be evenly spread with hot iron rakes, and while still pliable shall be rolled with a steam roller as above specified, so that when ultimate compression is accompilshed the surface shall be even and true to grade. The rolling must be steadily kept up, lengthwise, crosswise and diagonally, and continued until all roller marks disappear and surface shall give no appearance of further compressibility. Along the curb, around manholes and catch basins, where roller cannot reach, the required compression shall be made by the use of hot iron tampers. Tamping shall be done as quickly as possible after the material is spread, while it is still hot and pliable.

Joints—H-7.—All contact surfaces along curb, around manholes, castings, etc., shall be painted with an asphaltic cement before the paving mixture is laid.

The paving shall be done continuously, so that the number of joints between the hot and cold material shall be reduced to the minimum. When it is not practicable to lay it continuously, and a joint is unavoidable, the edge of the cold material shall be trimmed down to a rough feather edge and the surface where the joint is to be made painted over with asphaltic cement, and the hot material raked over the feather edge and thoroughly rolled; or, instead of trimming the cold material, joint strips may be used, consisting of strips of canvas about 18 in. wide, with three parallel lines of ¾-in. ropes sewed on the underside about 3 in. apart; the joint strips shall be laid on the feather edge of the freshly raked materials, with the upper rope at the line where the thickness begins to decrease, and the rolling completed on top of the canvas as for finished pavement.

Asphaltic Cement—H-8.—The asphaltic cement shall be composed of refined asphalt and flux.

Refined Asphalt—H-9.—The refined asphalt to be used under these specifications shall be approved and in every way satisfactory to the City Engineer. The refined asphalt shall be equal in quality to the recognized standards, and must comply with the following requirements:—

(1) All shipments of any one kind of material shall be uniform in consistency and composition, and shall not vary more than 15 points in penetration at 77° F.

(2) When the refined asphalt is made into an asphaltic cement by use of flux hereinafter specified it must produce an asphaltic cement of the required penetration satisfactory to the condition of the street, and at the penetration at which it is to be used it must comply with all requirements set forth herewith for asphaltic cement.

Fluxes—H-10.—The fluxes shall be residues obtained from the distillation of paraffin, asphaltic or semi-asphaltic petroleum. They must be homogeneous and of a uniform gravity, and free from all signs of cracking, and must comply with the following requirements:—

(1) They shall have a specific gravity at 77° F. of between 0.92 and 1.04.

(2) When 20 grms. of flux are maintained at a temperature of 170° C. for five hours in a cylindrical vessel 2½ in. in diameter there must not be volatilized more than 5 per cent. by weight.

(3) They shall not flash below 180° C. when tested in a New York State closed oil tester.

(4) They shall be soluble in carbon bisulphide to the extent of 30.5 per cent.

The asphaltic cement prepared as above described must comply with the following requirements:—

(1) It must be homogeneous, adhesive, viscous and must not be affected by the action of water.

---

* Specifications adopted by Vancouver, B.C.

(2) It shall have a penetration of between 50 and 70 per cent. at 77° F.

(3) When 20 grms. of asphalt are maintained at a temperature of 150° C. for five hours in a cylindrical vessel 2½ in. in diameter there must not be volatilized more than 5 per cent. by weight, nor shall the original penetration be reduced thereby over 50 per cent.

(4) The asphaltic cement shall not be so susceptible to changes in temperature as to have a penetration varying more than 125 between 0 and 45° C., and it shall have a ductility of not less than 5 cms. at 25° C., and not less than 2 cms. at 0° C. (Dow Standard).

Squeegee Coat—H-11.—Immediately after rolling, and while the pavement is still warm, a thin coat of pure bituminous cement shall be spread over the surface by means of rubber squeegees, and upon this shall be spread a thin layer of stone chips or other suitable material, dry and free from dust, and containing no particles which shall be less than ¼-in. ring nor greater than ½-in. ring. After applying dressing the surface shall be again rolled until it presents a smooth and finished appearance, subject to the approval of the Engineer.

Sheet Asphalt Pavement.

Subgrade and Drainage.—[The Subgrade and Drainage and the Foundation Requirements are the same as those given above for asphaltic concrete.—Ed.]

Binder Course—C-3.—The binder course shall consist and be made up and laid of what is known to the asphalt trade as "compact," or "coles" binder, and shall be composed of hard, clean broken stone (no gravel will be allowed or used in the mixture), which shall pass an opening 1 in. in diameter, the voids in which are filled with finer stone passing an opening ⅜-in. in diameter, while the voids in the mixed stone shall be filled with a well-graded sand.

To the stone and sand aggregate (after thorough mixing) sufficient asphalt cement shall be added to thoroughly coat the mineral aggregate with bitumen without showing any excess on compression with a hot tamper.

The stone and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a binder of the proper temperature for the material employed. The stone when used must be at a temperature between 200 and 335° F. The asphaltic cement when used must be at a temperature between 250 and 350° . The asphaltic cement and stone shall be thoroughly mixed by machinery in such proportions that the resulting binder shall have life and gloss without an excess of asphaltic cement, and the mixing shall be continued until a homogeneous mixture is produced in which all the particles are thoroughly coated with asphaltic cement.

Asphaltic Cement for Binder — C-4.— The asphaltic cement for the binder course shall have a consistency of at least 20 points, as indicated by the Bowen machine, higher than that in use in the surface.

Laying — C-5.—The binder mixture, prepared in the manner described, shall be brought to the street in wagons at a temperature between 200 and 325° F., and shall be covered with canvas covers while in transit. The temperature of the binder mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the binder. On reaching the street it shall at once be dumped on the concrete, and then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes, and then at once be thoroughly compacted by tamping or rolling. The depth of the finished binder shall average not less than 1 in. in thickness, and its upper surface shall be parallel to the surface of the pavement to be laid. The surface, after compression, shall show at no place an excess of asphalt cement, and any spot covering an area of 3 sq. ft. or more showing an excess of asphalt cement shall be cut out and replaced with other material. All binder which shows lack of bond, or that is in any way defective, or which may become broken up before it is covered with wearing surface, must be taken up and removed from the street and replaced by good material properly laid in accordance with these specifications at the expense of the contractor. Binder when laid shall be followed and covered with wearing surface as soon as is practicable in order to effect the most thorough bond between the binder and the wearing course. The binder course shall be kept as clean and free from traffic as is possible under working conditions. If necessary it must be swept off immediately before laying the wearing surface on it.

No binder shall be laid when in the opinion of the Engineer the weather conditions are unsuitable, or unless the concrete on which it is to be laid is dry and has set a sufficient length of time.

Wearing Surface.— C-6.—The wearing surface shall be composed of sand, filler and asphaltic cement, as hereinafter specified, mixed in the proper proportions.

Sand.—The sand must be clean, moderately sharp, and having a grading not varying more than 5 per cent. from the following limits; i.e., 5 per cent. from the three combined gradings:—

Standard Grading.

Bitumen		12.0%	
Passing 200-mesh	14.0%	.0000%	
Passing 100-mesh	12.6%	0.1702%	
Passing 80-mesh	10.4%	0.1405%	= 31.7%
Passing 50-mesh	23.0%	0.3108%	
Passing 40-mesh	10.0%	0.1351%	= 44.6%
Passing 30-mesh	9.0%	0.1210%	
Passing 20-mesh	5.0%	0.0620%	
Passing 10-mesh	4.0%	0.0540%	= 23.7%

Filler.—The filler must be thoroughly dried limestone, or other inorganic dust, or Portland cement. The whole of it shall pass a 30-mesh screen, and at least 70 per cent. of it shall pass a 200-mesh screen. From 5 to 15 per cent. of dust shall be added to the surface mixture, depending upon the kind of dust used, grading of sand, and traffic conditions of the street.

Asphaltic Cement.—[Same as for asphaltic concrete, given above.—Ed.]

Preparation.—C-8.—The wearing surface shall be composed of sand, filler and asphalt cement of the character elsewhere specified, and mixed in proper proportions. The sand and asphaltic cement shall be heated separately to such a temperature as will give, after mixing, a surface mixture of the proper temperature for the materials employed. The sand when used must be at a temperature between 250 and 375° F. The asphalt cement when used must be at a temperature of between 250 and 350° F. The filler shall be added to the hot sand in the required proportions and the two thoroughly mixed. The asphalt cement in the proper proportions shall then be added, and the mixing continued for at least one minute in a suitable apparatus until a homogeneous mixture is produced in which all particles are thoroughly coated with asphalt cement. The weights of all materials entering into the composition of the wearing surface shall be varied in the presence of inspectors as often as may be required, and the Engineer or his representative shall have access to all parts of the plant at any time.

Laying—C-9.—The surface mixture, prepared in the manner above described, shall be brought to the street in wagons at a temperature between 230 and 350° F., and shall be covered with canvas covers while in transit. The temperature of the surface mixture within these limits shall be

regulated according to the temperature of the atmosphere and the working of the mixture and the character of the materials employed. On reaching the street it shall at once be dumped on a spot outside of the space on which it is to be spread. It shall then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes in such a manner that, after having received its final compression by rolling, the finished pavement shall conform to the established grade and have a thickness of not less than......in. Before the surface mixture is placed all contact surfaces of curbs, manholes, etc., must be well painted with hot asphalt cement. After raking, the surface mixture shall at once be compressed by rolling or tamping, after which a small amount of cement shall be swept over it, and it shall then be thoroughly compressed by a steam roller weighing not less than 200 lbs. to the inch width of tread, and the rolling being continued until a compression is obtained which is satisfactory to the Engineer. Such portions of the completed pavement as are defective in finish, compression or composition, or that do not comply in all respects with the requirements of these specifications, shall be taken up, removed and replaced with suitable material, properly laid in accordance with these specifications, at the expense of the contractor. Whenever so ordered by the Engineer a space of 12 in. next the curb shall be coated with hot asphalt cement, which shall be ironed into the pavement with hot smoothing irons.

No wearing surface shall be laid when, in the opinion of the Engineer, the weather conditions are unsuitable, or unless the binder on which it is to be placed is dry. The finished pavement must be well protected from all traffic by suitable barricades until it is in a proper condition for use.

Requirements—C-10.—The finished pavement shall contain not less than 12 per cent. of bitumen soluble in cold carbon disulphide, depending upon the mesh composition and the character of the sand used and the traffic to which it is to be subjected, but in all cases sufficient asphalt cement must be used to properly coat all the particles of the mineral aggregate. It must also contain not less than 10 per cent. of mineral matter passing a 200-mesh sieve, and not less than a combined total of 25 per cent. passing the 200-, 100- and 80-mesh sieves. On streets of light traffic, when the Engineer has approved the use of a coarser sand or mixture than that specified for general use, the surface mixture must contain not less than 5 per cent. of mineral matter passing a 200-mesh sieve, and not less than a combined total of 18 per cent. passing the 200-, 100- and 80-mesh sieves. The maximum amount of 200-, 100- and 80-mesh material in the pavement will be regulated according to the kind of sand and asphalt used and the traffic upon the street on which the pavement is to be laid, subject to the maximum requirements elsewhere herein specified under sand and filler.

The above limits as to mesh compositions and per cent. of bitumen are intended to provide for such permissible variations as may be rendered necessary by the raw materials used and the character of the work to be done. The composition of the wearing surface may be varied within the limits above specified at the discretion of the Engineer, depending upon the kind of sand, filler and asphalt used and traffic conditions upon the street or streets to be paved.

Condition at Expiration of Guarantee—C-11.—In addition to the proper maintenance of the pavement during the period of guarantee the contractor shall, at his own expense, just before the expiration of the guarantee period, make such repairs as may be necessary to produce a pavement which shall:—

(a) Have a contour free from depreciation of any kind exceeding ½ in. in depth, as measured between any two points 4 ft. apart on a line conforming substantially to the original contour of the street.

(b) Be free from cracks, showing disintegration of the surface mixture.

(c) Contain no disintegrated surface mixture.

(d) Not have been reduced in thickness more than ⅜ in.

(e) Have a foundation free from such cracks or defects as will cause disintegration or settling of the pavement or impair its usefulness as a roadway.

GOOD ROADS EXHIBITION.

The first Good Roads Exhibition to be held in Canada will be in the Dairy Building, Toronto Exhibition Grounds, from the 24th inst., to March 1st.

The dates were set to be concurrent with the Toronto Motor Show and with the annual meeting of the Ontario Good Roads Association, which will be from the 26th to the 28th inst. The Exhibition will be under the management of Messrs. Hartley Robinson and E. M. Wilcox. The manager's office is 62 Temperance Street, Toronto.

Single fare on all railways for the entire week has been secured, and a good attendance is anticipated, both at the Motor Show and the Good Roads Show. There will be a number of interesting exhibits by the Patterson Manufacturing Company, Rocmac Road Construction Company, Ontario Bridge Company, Wettlaufer Brothers, The Canadian Engineer, Canada Cement Company, the University of Toronto, Sawyer-Massey Company, etc.

Delegates will be present at the meeting of the Ontario Good Roads Association from most of the cities, towns, villages and counties throughout the province, and highway officials from various parts of Canada and the United States will be present to address the meetings. Some of the speakers will be Sir Lomer Gouin, the Premier of Quebec, who has aroused that province this year to the importance of good roads; Colonel Sawyer, chairman of the Massachusetts Highway Board; Honorable A. R. Reaume, Minister of Public Works for the Province of Ontario; W. A. McLean, provincial engineer of highways for Ontario. County road organizations, construction of roads, maintenance, federal aid, provincial aid, and other subjects will be discussed.

The members of the association will undoubtedly find the Good Roads Show, which will be very handy to their meetings, both interesting and attractive. Both the practical and theoretical sides of road building will thus be presented, as sections of roads with practical demonstration will be seen at the show.

The Ontario Good Roads Association is a very important body of public-spirited men who have accomplished, among other things, the abolition of statute labor in many townships in Ontario; the adoption of the Highway Improvement Act in twenty counties, in which 3,771 miles of highway have been assumed for improvement; the expenditure of $3,393,507 in the improvement of county roads, one-third of which was paid by the province; and the appropriation by the province in 1912 of an additional $1,000,000 for the purposes of the Highway Improvement Act.

CONVENTION OF CANADIAN ELECTRICAL ASSOCIATION.

The Executive Committee of the Canadian Electrical Association of Toronto have decided to hold the next annual meeting of the association at Fort William on June 23, 24, 25. About 600 delegates and members from every part of the Dominion will be asked to attend.

COAST TO COAST.

Halifax, N.S.—The work of constructing the new No. 2 terminal pier at Deep Water has commenced. The construction, which is in charge of the Nova Scotia Construction Company is very interesting. At present concrete piles of 11 to 23 tons in weight are being driven into the sea bottom by a 16-ton steel hammer; 1,818 of these piles are necessary for the foundation of the pier.

Detroit, Mich.—The Great Lakes Engineering Works will construct three great steel car ferries for the Grand Rapids and Northwestern Railway to be used on Lake Michigan between Ludington and Manitowoe. The probable cost will be in the neighborhood of $1,500,000, and the boats will be built on the same style as the SS. Astabula, of the C.P.R. Company, but with a length of 350 feet.

Edmonton, Alta.—The provincial telephone system yielded a net profit of $62,283 for 1912. During the last six years the net profits have been $407,582. Premier Sifton reported that $2,000,000 will be spent to increase and extend the telephone system until every farmer and resident is accommodated with this utility, which is almost as necessary as railroads.

Montreal, Que.—Mr. Jos. Irving, in company with Hon. Clifford Sifton, is in London enlisting the support of English capital in the formation of the International Cement Company, of Hull, which was temporarily abandoned last spring. The company proposes to use a new process in the manufacture of cement and to have a capitalization of $10,000,000.

Montreal, Que.—The Canadian Ice Company, which is incorporated under a federal charter for $500,000, is doing its utmost to obviate the threatened ice shortage. Additional storage buildings are being built.

TORONTO UNIVERSITY ENGINEERING SOCIETY ANNUAL DINNER.

Thursday evening, February 13th, witnessed the twenty-fourth annual dinner of the Engineering Society of the University of Toronto, held at McConkey's, King Street West, Toronto. The affair was a general success, the attendance altogether being nearly three hundred members and guests. The programme of the evening had been arranged with care, and all present seemed to appreciate and enjoy it. Mr. J. E. Ritchie, the president of the Society, had the chair. The speakers of the evening were: Sir Edmund Walker, chairman of the Board of Governors of the University; Dr. R. A. Falconer, president of the University; Dean Galbraith; Dr. W. H. Ellis; Mr. David Molitor, consulting engineer and designing engineer of locks and dams of the Panama Canal, three years professor of Civil Engineering at Cornell University; Messrs. J. B. and J. W. Tyrrell; Mr. J. S. McCannell, president and general manager of the Milton Pressed Brick Company; Mr. J. L. Morris, the oldest graduate of the "School," and Messrs. T. V. McCarthy, D. A. Mutch and F. C. Mechin. Excellent music was supplied throughout the evening by the Science orchestra and the Science octette and others. The menu cards, of admirable and original design, were furnished by the Eugene Dietzgen Company.

Class '09 of the Faculty of Applied Science of the University of Toronto held a re-union dinner at the St. Charles in Toronto, Friday evening, February 14th. Over sixty members of the class were present on this occasion. Mr. W. D. Black, the toast master, was unanimously elected president for the ensuing three years.

PERSONAL.

RAY R. KNIGHT, recently appointed city engineer of Fort William, has left for that city.

JAMES G. LINDSAY, engineer and waterworks manager of Belleville since April, 1908, has resigned his position.

MR. JOS. D. EVANS has resigned his position as chief engineer of the Montreal Tramways Company to become construction manager of the Electric Bond and Share Company, of New York City.

MARCIL PEQUEGAT, honor graduate of '08 and instructor of drawing of the School of Practical Science, Toronto, has been appointed city engineer of Berlin, Ont. Forty applications were received for the position.

MR. ALVIN SCHLARBAUM, B.A.Sc., has severed his connection with Messrs. Smith, Kerry and Chace, as assistant engineer on the Healey Falls development, to accept the position of hydro-electric engineer for the Riordon Pulp and Paper Company, Limited, of Hawkesbury and Merritton, Ont.

H. T. HAZEN, government engineer in charge of the Hudson Bay Railway terminal at Port Nelson, has arrived in Winnipeg after completing the 700-mile journey from the mouth of the Nelson River. On Mr. Hazen's report will depend the Minister of Railways' decision on the location of the Hudson Bay port.

MONSIEUR J. M. F. de PULLIGNY, ingenieur en chef des Ponts et Chaussees, et Directeur, Mission Francaise d'Ingenieurs aux Etats-Unis, New York City, on February 11th delivered an illustrated lecture on "The Public Service of Roads in France," before the graduate students in Highway Engineering at Columbia University.

MR. ALFRED STILL has resigned his position as chief electrical engineer to the mines department of the Algoma Steel Corporation of Sault Ste. Marie, Ontario, Canada, to take charge of the courses in electrical design at the School of Electrical Engineering, Purdue University, LaFayette, Indiana. Mr. Still, who is a member of both the British and American Institutes of Electrical Engineers, has made a special study of hydro-electric developments and long-distance transmission of electric energy. He has lately returned from a trip to Denver, Salt Lake City, and San Francisco, where he has visited many of the important power systems.

OBITUARY.

MR. WM. JOHNSTON SPROULE, M.E., died at his home at St. Lambert, Que., February 6. The deceased was a member of the Canadian Society of Civil Engineers and was connected with the Montreal habor commissioners for 30 years as assistant engineer, retiring two years ago.

GEORGE WILLIAM MAYNARD, mining engineer, who introduced the Thomas basic steel process into the United States, and who had been widely known in the West and abroad as a consulting engineer, died at Boston, Mass., on February 13. His home was in New York, where he was born in 1839. He was one of the original members of the American Institute of Mining Engineers.

JOHN FRITZ, one of the best-known mechanical engineers in the United States, died at the age of ninety years at his home in Bethlehem, Pa., on the 13th inst. Among other positions of responsibility held at various times by Mr. Fritz were the general superintendency of the Cambria Iron Works, at Johnstown, Pa., and the general superintendency of the Bethlehem Steel Works. In 1864 Mr. Fritz built a rolling mill at Chattanooga, Tenn., for the United States Government, and in the years that followed he was an active

factor in the development of the Bessemer process, the acid and basic open-hearth and the electric furnace. He was a past president of the American Society of Mechanical Engineers; a past president of the American Institute of Mining Engineers; a member of the American Society of Civil Engineers; an associate fellow of the American Academy of Arts and Sciences; and honorary vice-president of the Iron and Steel Institute of Great Britain. From the last named society he received the Bessemer gold medal in 1893 for notable service in advancing the manufacture of steel. He was awarded the John Fritz medal by the United Engineering Societies in 1902, and the Elliott Cresson medal in 1910.

AMERICAN SOCIETY MECHANICAL ENGINEERS.

The American Society of Mechanical Engineers will hold a joint meeting with the Verein Deutscher Ingenieure in Germany, beginning June 22nd, 1913. The principal industries of Germany will be visited, including the Krupp Iron Works, at Essen.

COMING MEETINGS.

ILLUMINATING ENGINEERING SOCIETY.—A joint meeting of Societies will be held at the Republican House, Milwaukee, Wis. Feb. 22, 1913.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March, 3, 4 and 5, 1913, in the Green Room, Congress Hotel and Annex, Chicago, Ill. Secretary, Will P. Blair.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill: Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James: Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. Mc Murchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—P ident, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, Feb. 27, 1913 Contents of this issue on page 371

The Canadian Engineer

An Engineering Weekly

PRECISE SURVEYS FOR MOUNT ROYAL TUNNEL

By J. L. BUSFIELD, B.Sc., A.C.G.I.

The Canadian Northern Railway have under construction a double-track tunnel about 3½ miles long through Mount Royal, on the west side of the city of Montreal. This tunnel is being built in order to bring the lines of railway from the east and west of Montreal right into the heart of the city, where a large terminal station is to be built.

The construction of a long tunnel usually means that very precise surveys and measurements have to be made as a preliminary step to the actual work of boring, and the Mount Royal tunnel is no exception to the general rule.

In driving a tunnel it is customary to work from both ends towards the centre, and in this case a shaft was sunk down to the level of the tunnel at an intermediate point and the tunnel is being driven both ways from this shaft, as well as from the ends. In order to insure that all these workings will correctly meet, it is essential that their locations with regard to each other should be very carefully established, both with regard to alignment and also for elevation and distance apart. To obtain the correct alignment, a line is, when possible, run on the surface in the same vertical plane as the tunnel, and precise transverses or triangulation must be resorted to for the distances. The necessity for accuracy will readily be understood on account of the fact that once the lines and levels are transferred into the tunnel no further check is obtained until the different workings meet.

Fig. 1.
Letting up Spider.

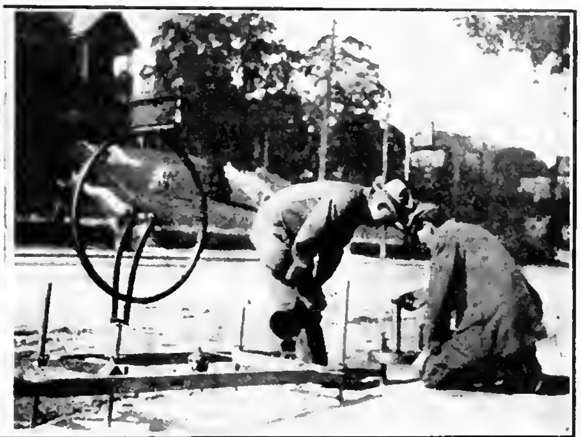


Fig. 2.
Chainman Reading Tape; Tension Wheel at Left.

On account of the steep and inaccessible slopes of the mountain it was deemed advisable to make transverse surveys around the side in order to obtain the exact distance from the east to the west portal, and also to the intermediate shaft at Maplewood Avenue. Suitable routes were selected and at all the angle points (called stations and given consecutive numbers for reference) small copper plugs were set into the sidewalks, or, in the few cases where there were no sidewalks, into the solid rock.

In order to make the transverse sufficiently accurate, the length of the route being about 4½ miles, it was necessary to adopt some form of base line measurement. The form decided upon as being eminently suitable for use on sidewalks and roads was that of portable measuring points called "spiders," used in conjunction with a steel tape supported at twenty-foot intervals, with a tension of twelve pounds applied by means of a weight attached to a cord passed over a bicycle wheel on an adjustable frame. These spiders are illustrated in Figs. 1 and 2, and weighed about sixty pounds each. The tension wheel is shown in Fig. 2.

Previous to making the precise measurements "spider" points were marked on the sidewalks by means of a chiselled cross roughly every ninety-nine feet on the lines of the transverse, being put in line between the angle points either by eye or with a transit. The necessity for exact alignment not being very great as an offset of 0.43 feet on either side of the line would only introduce an error of one thousandth of a foot in the length of the line. Where the lines were not on sidewalks, stakes or ship spikes were driven to mark the spider points. While these were being laid out by one party, a leveller would follow and take the elevations of all the spider points and enter them up in a book provided for that purpose.

In making the base line measurements 100-foot steel tapes were used of ¼-inch steel, divided into feet, tenths and hundredths, the thousandths being estimated by the observer. One steel tape was sent to the Bureau of Standards to be standardized under the same condition as the tapes were to be used under in the field, i.e., supported at 20-foot intervals with a tension of 12 lbs. It was compared with the government standard at a temperature of 62 degrees so all temperature corrections made later were to this figure.

All the tapes to be used in the base line measurements were compared with this standard tape. The standard tape and the one to be compared were fastened at the zero end to

two adjusting screws over a brass plate with a fine straight line on it; at the 100-foot end they were both attached to cords passing around two bicycle wheels with a twelve-pound weight attached to each. (See Fig. 3). The two 100-foot ends of the tapes rested on another brass plate with two scales on its face divided into thousandths of a foot; after the two zero ends had been placed exactly over the line on the first plate the readings on the scales at the other end were taken. The two tapes were then reversed and corresponding readings again taken. This process was repeated several times for each tape and an average taken.

All these preliminary arrangements being completed, the actual measuring was commenced, the method of procedure being as follows:—

First.—Two men would take the spiders and place them as nearly as possible with the cross marks vertically over the spider points. (Fig. 1). At the same time two other men would be setting up the tension wheel frame at a short distance to the rear of the rear spider. This frame is illustrated in Fig. 2, and needs no special description, except that it had adjustable legs and wheel so that it could always be put at the right height, even on the roughest ground encountered. At the front spider a forestay was set up to hold the front end of the tape. This forestay was simply a fairly heavy cast iron plate with a vertical post, upon which was a sliding clamp to which was attached an adjustable cord for holding the tape. A heavy weight was placed on the back of the plate to resist the pull of the 12-lb. tension weight.

Second.—The rear chainman would call out "Ready for tension" and thereupon the first chainman would attach the front end of the tape to the forestay and the rear chainman applies the tension of the weight by shortening the adjusting cord.

Third.—The rear chainman now stoops down until his eye is on the level and in line with the tops of the two spiders, and lines in the four wooden standards for supporting the tape at twenty feet intervals, so that the hooks are all in the same straight line between the tops of the spiders, and then the tape is hooked up into the hooks. The standards were made of a wooden base with a 1-inch-square vertical post with a sliding block held by a spring, a cord with a hook for holding the tape was hung from the block. A thermometer was also hung on each block in such a position that its bulb was as close to the tape as possible.

Fourth.—The chainman, having seen that there were no twists in the tape, they would take up their positions at the spiders, and the "recorder," who kept all the field notes, would take his position midway between them, calling out "ready to read" as soon as everybody had taken their place. On this signal the two chainmen would call out in turn the height of the top of the spider above the spider point on the ground which they measured with folding rules. This gave the correct elevations of the tops of the spiders, hence the slope of the tape. The head chainman then calls out the readings at his end of the tape at the intersection of the scratch on the spider, and the recorder enters it in his book, the rear chainman reads his end of the tape at the same instant as the head chainman, but does not call out until the recorder has had time to enter the first reading. The recorder then calls "change," and the tape is allowed to move bodily a very small amount one way or the other, so that a different reading is obtained at both ends, which are again called out to the recorder. This process is repeated until the recorder gets five or six readings which do not vary more than a thousandth or so. While this is being done another man is reading the four thermometers on the standards, the mean reading of which he gives to the recorder. The following is an example of the booking of one set of readings:—

Point.	Readings.	Difference.	Height of spiders.	Temp.
Line 14-15	99.478	99.151	Sp. 4 1.71	
	0.327			
Sp. 4 to 5	99.506	99.150		74.0°
	0.356			
	99.575	99.151		
	0.424			
	99.594	99.151	Sp. 5 1.69	
	0.443			

Fifth.—Having obtained a good series of readings, the recorder calls "unhook," and the tape is unhooked and the whole apparatus is moved forward to the next spider-point, the rear spider being left in its position to retain the measurement in case the one just measured to should be dis-

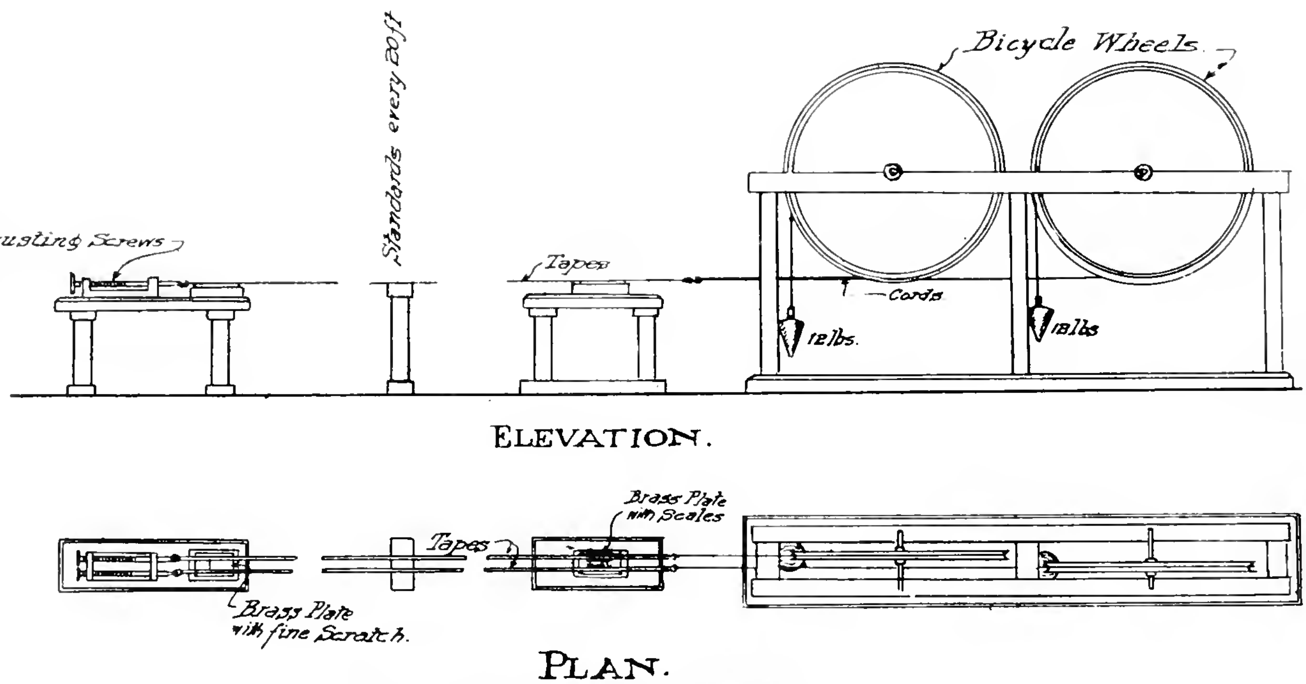


Fig. 3.—Sketch of Tape-Testing Apparatus.

turbed. Whilst the actual measuring is taking place two men carry up a spider and place it at the next spider point ahead.

At the starting point and all rivet stations, instead of one of the spiders being placed over the rivet it was placed a foot or two ahead merely as a support for the tape, and the reading on the tape was obtained by transferring the point on the rivet up to the tape by means of a transit placed a short distance away and at right angles to the tape.

This method of measuring required ten men, namely, chief of party, transitman, recorder, two chainmen, two spider-placers, one thermometer reader, one man for fore-stay and one man for tension wheel. Under favorable conditions as many as 15 to 18 stations were measured in an hour, but 10 stations per hour would make a good average for a day's work.

The majority of the work was done in the daytime but in the busy sections of the city it was done during the night, no difficulty being experienced from the darkness, acetylene miners' lamps being used.

Having made the measurements in the field, the correct distances between the stations were computed in the office, making the necessary corrections for the reduction of the distance to horizontal, for temperature, and the tape correction to standard, the two former being obtained from diagrams plotted for that purpose.

Great care had now to be taken in reading the angles of the transverse. A Berger transit, 7-inch plate reading to 10 seconds was used. In setting the instruments up over the angle points a second transit was used to insure the vertical axis of the instrument being exactly over the centre of the cross on the rivet. At the two points sighted at, wooden targets were used, being set up vertically and precisely over the points by means of a transit. These targets were made of wood 4 inches wide and about 3 feet high, and were divided into red and white triangles. Adjustable tripod legs were used to support them. In reading the angle one observer would read the angle once, and then wrap it up five times, and then go backwards until zero was reached again on sighting at the first target, to insure that the plates had not slipped. This would give a very close determination of the angle to 2 seconds, and this process was repeated by an independent observer, thus giving a mean determination down to 1 second. Every precaution was taken to eliminate any instrumental errors, and also to protect the instrument from the heat of the sun. In a circuit five miles long with 33 angles there was only an error of closure of 1 second, and in another of three miles and 10 angles the transverse closed exactly by the angles, and in none of the circuits was there an error of more than a few seconds. All the important transverses were duplicated by independent routes giving a complete series of closed transverses, and from the base line measurement an average degree of error was found to be about 1 in 40,000.

The measurements around the mountain being completed, it was necessary to project a line over the mountain in the same vertical plane as the tunnel centre line.

To do this the minimum number of transit points were selected and permanent concrete monuments built to hold the line. In setting up a transit at a monument plumb-bobs were discarded entirely and the transit was bucked into line until the cross hairs intersected both the far away back sight and also the cross scratched on the monument close to it. The line was then projected to the monument ahead time after time, reversing the instrument between each sight.

A mean was taken of all the points obtained at the foresight monument and the line thrown ahead from that point in the same way.

The surveys for the whole work were tied into the city system of base lines and a series of co-ordinate lines was adopted so that the latitude and departure of any point could be readily obtained, hence its distance and bearing from any other known point. All the survey alignment points in the tunnel are also being referred to the same co-ordinate lines. The levels were transferred from the city to the west portal in as accurate a way as possible with standard instruments; 18-inch wye levels were used with target rods. The level was set up three times for each turning point, these never being more than about 100 feet from the instrument and equidistant therefrom. The whole operation was repeated four times with independent observers. The difference in their elevations of corresponding bench marks being only a few thousandths of a foot.

In the city itself it was decided to put in permanent survey monuments at the more important and strategic stations. These monuments (Fig. 4) were made by digging a hole about 7½ feet deep and filling the bottom to a depth of about 2½ feet with concrete, in which was set the monument proper, made of 6-inch cast iron pipe at the bottom, with a 4-inch pipe inserted into it at the top with a leaded joint, the object of this being to enable the top of the pipe to be easily lowered again in case the whole pipe should be heaved by frost. This, of course, is an unexpected contingency. In the top of the smaller pipe a piece of brass was cemented and on this the precise cross scratch was made, and also the precise elevation taken. After the concrete had set, the space surrounding the pipe was rammed with earth or sand taken from the hole, and on top of this a cast iron cover plate and base set with concrete into the sidewalks was placed, thus making a good permanent point free from disturbance and easily accessible.

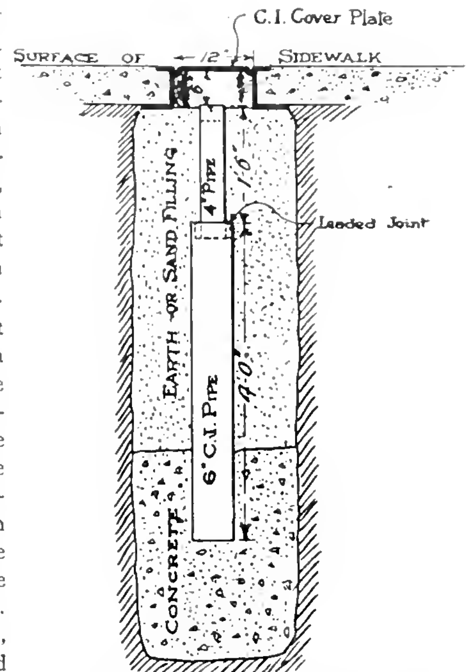


Fig. 4.—Permanent Monument for Tunnel Survey.

The surveys and measurements for the tunnel, which were all carried out under the immediate supervision of the writer, although requiring great accuracy, were comparatively simple, compared to the alignment work in the tunnel, because frequent checks on the work could be obtained, whereas in the tunnel no checks are obtainable until the headings are run into one.

The government owned telephone system of Alberta yielded a surplus of receipts over operation and maintenance expenses during 1912 of $62,283, while the earning capacity of the system on a basis of the capital expenditure amounted to 12.1 per cent. In the six years, 1907-1913, the system has yielded a profit of $407,592.

THE REPLACEMENT OF GASOLINE.

By H. Poynter Bell.*

The great and rapid increase in the price of gasoline is, not unnaturally, exercising the minds of the owners and users of gasoline motors all over the world. In New York, for instance, the price rose from 9 cents to 16 cents per gallon between January and July of last year, and the New York Garage Association is giving serious attention to ways of meeting the situation.

Two ways seem to have commended themselves. Firstly, the encouragement of competition in the sale of gasoline, and secondly, the establishment of a uniform standard of of quality, which may allow of increased production. The first way depends upon the suggestion that the increase of price is due, wholly or partly, to the action of the "Trust." There may be some truth in this, but it is certainly not the whole truth; the increase is largely, at any rate, due to ordinary economic causes.

Fifteen or twenty years ago the most important product of petroleum was kerosene; gasoline was merely a by-product and was used chiefly as a solvent. With the increased demand for gasoline, and a simultaneously decreased demand for kerosene, it is the latter which has become the by-product, with the consequence that the gasoline has now to bear the chief share of the cost of production.

At the same time, though the world's output of petroleum has increased, the yield of gasoline has not increased at anything like the same rate. There has been some falling off in the percentage of gasoline in the oil from the older oil fields, owing no doubt to evaporation, and the oil from the more recently opened fields is generally a heavier oil containing a lower percentage of gasoline. The crude oil from Pennsylvania contains about 16 per cent. of gasoline and liquids lighter than kerosene; the California crude oil contains not more than 3 per cent. of such liquids. The Russian (Baker) petroleum yields about 6 per cent. The resulting position of things is such that the producers, having too large supplies of kerosene, have felt obliged, in some cases, to refuse to sell gasoline to buyers who will not take a corresponding quantity of kerosene. It seems to follow that, under the circumstances, no great or long continued reduction of price can result from competition by rivals of the Standard Oil Company or other large producing organizations.

Rather more may perhaps be expected from the fixing of a legal standard for commercial gasoline. The production of so great a variety of motor spirits as is now sold must necessarily be more or less wasteful. If a liquid of fairly high specific gravity and boiling point could be made the standard, there would be an increased production from the present supply of crude oil, while there would be, at the same time, greater safety in the handling and storage of gasoline. To be of any real use, the standard would have to be fixed by law, and it may be doubted if this is likely to happen, since public safety is hardly concerned, as in the case of the flash point of kerosene.

In any case, measures of this kind can only give temporary relief and not permanent cure. Calculations of the duration of the world's supply of petroleum need hardly be taken into account. Such calculations have been made by Prof. Vivian Lewes, in England, and others; but apart from the fact that the quantity of the known supplies is very hard to estimate, no good guess can be made at the quantities which remain to be discovered. Assuming, however, that the demand for volatile liquid fuel continues to increase at the present rate, it will certainly exceed any increase of the supply which can reasonably be expected from the oil fields. That is to say, the users will, sooner or later, have to face not merely rising prices, but an actual shortage of supply.

The consumer of the future will, therefore, have to be resigned to paying more for his fuel, and must be satisfied if he can get it in such quantities as he wants. To produce even this result a liquid capable of replacing gasoline is likely to be needed, and for the production of such a liquid a prize of the value of $100,000 has recently been offered by the International Association of Automobile Clubs at their meeting in Paris.

The substance required is one which cannot be rigged or cornered by any nation or combination of national interests. It must, therefore, be capable of being produced in almost every part of the world, and must, further, be made from some raw material of which the supply is either practically unlimited or capable of being continually renewed. No fuel can be obtained from the atmosphere; no liquid fuel can be obtained from water, so that the only unlimited or renewable sources are animal and vegetable matter, of which only the latter is likely to be of much use. It may be that a method can be found of making, sufficiently cheaply, gasoline, or some similar liquid, direct from vegetable matter. At present there is one, and only one, liquid known which can fulfil the required conditions, that is, of course, alcohol.

Alcohol is suitable, in most respects, to replace gasoline, though its heating value is, unfortunately, considerably lower than that of gasoline. The value varies, of course, with the proportion of water which the alcohol contains, but pure alcohol has only about 7/11 of the calorific value of an equal weight, or about ⅔ of that of an equal volume of gasoline. That is to say, that to replace a gallon of gasoline there will be needed not less than 1½ gallons of alcohol. The disadvantage is not necessarily prohibitive, and it may be that consumers will have to put up with it. Alcohol can, of course, be produced in practically unlimited quantities, and at a low cost. The cost can certainly be reduced if a large enough demand arises, since little, if anything, has been done so far in the direction of selecting and cultivating plants with a view to a maximum yield of industrial alcohol. The matter will be one of the problems of utilizing the sun's heat for producing fuel which were indicated by Prof. Ciamician, of Bologna, in his lecture on the "Photochemistry of the Future," before the International Congress of Applied Chemistry, at New York.

The chief difficulty in connection with the use of alcohol will consist in reducing the restrictions and the excise and other duties, which are placed on the sale of alcohol by practically all governments. It will be for automobile associations and similar bodies to attack this side of the matter, while chemists may have to satisfy the requirements of the governments by finding substances which will render alcohol undrinkable.

Alcohol is, no doubt, not an ideal substitute for gasoline, but it appears that there may be only the choice between developing the production and use of alcohol and waiting, perhaps in vain, for the discovery of some better substitute.

*Consulting Technical Chemist, Kent Building, Toronto.

The English shipbuilding firm, Messrs. Swan, Hunter and Wigham Richardson, whose president, Mr. W. G. Hunter, is now in Montreal, will submit tenders for work on the Georgian Bay Canal, if that project is proceeded with, and for the construction of ships for the Hudson Bay line.

FISHING STATION SURVEY IN THE GULF OF ST. LAWRENCE.

By J. A. Macdonald.

The accompanying map and text is interesting from the viewpoint of the methods employed in making the survey.

The survey was made, among others, for a fish-canning company, who have in operation a hundred or more canneries, situated at various points on the shores of the Gulf St. Lawrence.

The company are continually establishing new fishing stations and closing others as business warrants.

Before establishing a station at any new point they usually have a careful survey made of the shore: shelter for boats, large or small, ownership of property rights, accessibility to a public road and railway, survey of the fishing grounds, showing distance from shore of the various depths of water, or "fathoms deep," and distance from shore or harbor of the various fishing grounds, as herring, lobster, salmon, etc. In order to obtain all this information requires an expert hydrographic survey of the harbor or cove, and this is really what this is.

In the map the methods of measuring the depths of water in order to be plotted are shown by the dotted lines.

Two methods of ascertaining the contour or fathom depths were used, involving the use of both the transit and sextant.

In the one case the angles were read by transits on the shore—two transits one at each end of the base line AB—and in the other case by reading the angles with a sextant in the boat on the water. This later method is known as the "Three Point Method."

Let A′ B′ C′ be the three shore points, being defined by the two distances A′ B′ and B′ C′ and the angle of B′. Let the two angles at P′ be measured at the point P′. The problem then is to find the distance A′ P′ and C′ P′.

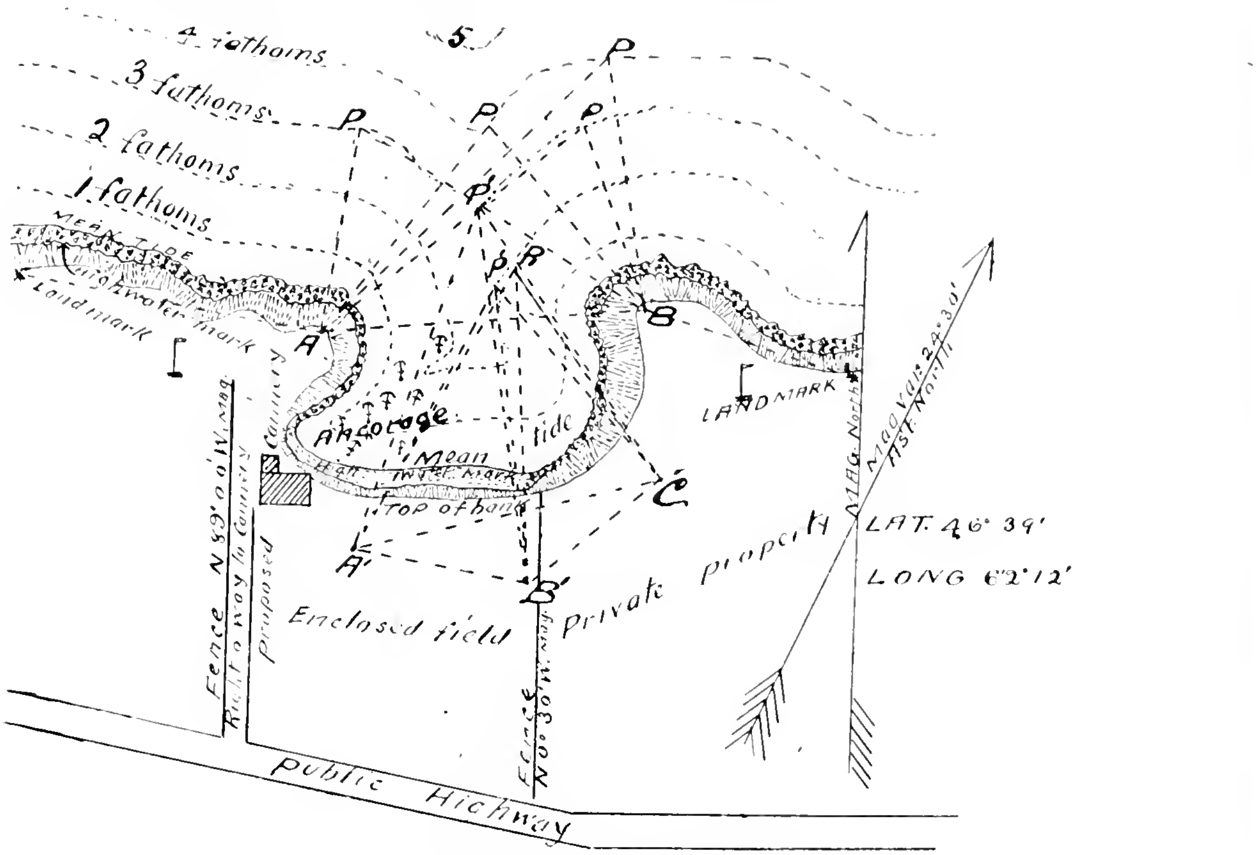
There is an analytical solution for this which, however, does not seldom need to have to be performed. It involves a good deal of figuring. The angles at P′ and the angle B′ are known, but the angles P′ A′ B′ and P′ C′ B′ are unknown. However, the formula gives:—

$$\cot. P'A'B' = \cot. R \left(\frac{A'B' \sin P'}{B'C' \sin P' \cos R} + 1\right),$$

$$\text{when } R = 360^\circ - B'P'C' + B'P'A' - A'B'C'.$$

I repeat that it is seldom necessary to use this analytical formula, though it is well to use it once in a while as a check, and should be used in all hydrographic surveys of this kind.

The so-called mechanical solution is simple and rapid by using a three-armed protractor. It is the common method of plotting soundings when two sextant angles have been read from the sounding boat.



Plan-Chart of Fishing Station in Gulf of St. Lawrence.

The angles in this case were laid off graphically on tracing paper by lines of indefinite length, and this laid on the plot and shifted in position until the three radial lines coincide with the three stations on the ground, A′ B′ and C′, when their intersection marks the point, P′, of observation. This is a most ready method of plotting such observations when no three-armed protractor is available.

By this method only one observer is required in locating the soundings, and no time is lost in changing stations, and the party are all together, and there is not likely to be any misunderstandings in regard to the work.

The other method here shown, two angles read on shore, two instruments are required, one at A and one at B on shore, and the angles subtended by the other fixed point and the boat P, as A B P and B A P, be read by both instruments. When a sounding is taken, the intersection of

the two pointings to the boat, when plotted on the chart containing the points of observation duly plotted, will be the plotted position of the sounding.

Two observers are required, which makes this method somewhat objectionable, and these must be transferred at intervals as the work proceeds, and in order to see the boat, P, at all times. Usually, three or more readings can be made from each position. For example, in the plot four positions of the boat at P are taken.

The base, A B, across the bay, was made by a stadia reading. The transit was set up at A and the rod held at B. Two other base lines were also laid off, as shown in the dotted lines, one from A westerly to point shown as landmark, and the other from B easterly to "landmark. For the three-point readings flagpoles were erected about the centre of the base lines and to the south in the same manner as A' B' C' in the plot. These are shown in the plot.

The shore line was first traversed at the water's edge. Offsets to the bank were estimated, and sometimes paced; no measuring was done. The first part westerly was rocky, with high, steep banks. Along the cove, or natural harbor, there was a sandy beach, with low banks. Around the point, again, it was rocky, with high cliffs. This is shown by the topography on the chart. The direction of the land lines, width, and property-owners were made, taking bearings with the compass. Direction and position of roads were determined, and everything necessary to complete the plot and give all the information required.

The cove or harbor was a natural one. A wharf could be built, and was later, below the cannery, making it convenient for landing fish. The anchorage was good for boats and small craft, and perfectly safe, except with north-east winds. The harbor was well sheltered from south, west and north-west, and these were the prevailing winds. A north-east storm would, however, drive right in to the harbor, and no craft could live at anchor in such a storm. With regard to the smaller craft, provision was made for hauling them up on the sand beach in the rare times of such storms. Larger craft would either have to ride it out or get away in good time.

The soundings in the boat were taken with lead and line marked in fathoms. At even fathoms positions were taken and the triangulations made either with sextant from the boat or with transit or compass from shore.

In plotting those soundings no calculations were needed. The intersections of the two or the three points showed the position of the boat at one fathom, two fathoms, etc.

The soundings in the harbor were mostly made by using a long 30-fathom marked line for distance, and the bearings from a known point on shore were made with a prismatic compass. No one method answers for this kind of work. One has to have a certain amount of initiative or originality in this kind of work.

Latitude and longitude were ascertained, the former by a reading of the sun's altitude with the sextant at apparent noon, and allowing for dip, semi-diameter, paralex, etc. The sextant is much more convenient and accurate for taking astronomical observations than is the transit. Longitude was calculated from the ascertained longitude of a lighthouse some twenty miles distant, assuming, of course, that the longitude of the lighthouse was correct. The magnetic declination was ascertained by an azimuth observation of the sun.

Surveys of this nature are very rare, and confined to marine and fisheries in Canada and to the coast and geodetic surveys in the States. In the building of breakwaters and harbor improvements by the Public Works Department such hydrographic surveys are always made. It is, therefore, confined largely to Government work, though in the case here described it was of a private nature.

ORGANIZATION OF A STATE HIGHWAY DEPARTMENT.*

By Maj. W. W. Crosby.†

The essentials for a successful state highway department may be said to be:—

1. An established demand for it.
2. A proper organization of it.
3. Sufficient funds for its work.
4. A well defined policy.
5. An honest, tactful, capable head.
6. Suitable locations for its headquarters and branches, proper equipment, and loyal and skilled employees.
7. Perfection in designs for its work and efficient execution of such designs.
8. A comprehensive system of accounting from which intelligible public reports are regularly made.

The title of this paper, and, as I understand, its purpose, confine the speaker to the second essential except as reference may seem necessary to one or more of the others, and such will be his effort.

From the speaker's experience, he believes that the subject of the organization of a state highway department should be viewed from two points. First, from the point of establishing such a department as will most likely succeed in acquiring for itself and for the movement for better roads sufficient stability to endure, and, second, from the point of view, after such a stage has been reached and public support both moral and financial assured, of then increasing its efficiency.

Now for the stable upbuilding of a state highway department, the speaker believes a state commission of three is best. Five are ordinarily unnecessary and less likely to form a facile and mobile unit. They are likely to separate into five units and not to amalgamate into one uniform and homogeneous body, and this lack of unity will surely produce rivalries and schisms.

One commissioner, on the other hand, is ordinarily weak in a number of points. The selection of one man with the necessary tact, honesty, and executive ability, and, at the same time, possessed of either the proper engineering skill or the recognition of his lack of it and with the breadth to acknowledge such lack by the employment of a skilled engineer assistant, is a most difficult task to set any appointing power. Further, with "but one neck to be lopped," a single-headed commission is far more susceptible to the temptations of politics and to the attacks of enemies. The demands of questions of policy, of law, of administration, of execution, and of engineering are too great and diverse to be satisfactorily and permanently met by more than one man in a thousand and the chances for the appointment of that man in any case are probably not one in one hundred when the various influences concerning such appointments, the salary likely to be offered, and all the other factors are considered. With a commission of three, properly selecting and protecting its engineer, the latter can do the public, his board, his subordinates and himself, much more nearly actual justice than if he is obliged to act as both commissioner and engineer.

Under any commission there should be employed a trained and competent chief engineer. Probably the commission will also need to employ a secretary and certain book-

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

† Chief Engineer, Maryland Geological Survey.

keepers, clerks and stenographers reporting to and under the authority of the secretary. Legal counsel may be generally advisable and should report directly to the board or its chairman. A right of way agent may be necessary and he may report to the counsel or to the secretary, as deemed advisable. The chief engineer should be the chief executive officer of the board, and he should be given all the authority necessary to make this fact fully and finally realized. As such, his responsibility to the board would be definite and the board should do nothing to muddy the waters of this situation.

The speaker wishes to say here that it seems to him that more inefficiency, with its waste of money and unsatisfactory results, has come from division or lack of clearness in responsibility than from incompetence.

In such a position as above described, a chief engineer can not only afford to be perfectly open and frank in expressing his opinions to his board, but he is encouraged to do so to the extremes of his ability. The board may then act more intelligently. In cases, where in its opinion the other considerations outweigh the engineering ones and the decision seems to be against the recommendations of the chief engineer, the latter feels his relief from the responsibility, and his efforts to properly carry out the decision of the board should, and probably will, be more earnest and effective.

Under the chief engineer should be two assistant engineers selected by him—as, it might be said here once and for all, should all the employees of the engineering department. One should be in charge of the construction, the other of the surveying and planning. But the plans should always go up to the chief engineer through the assistant in charge of construction. The benefit of criticisms from the workers in the field will then be had before it is too late to make changes without complications or serious expense and many of the routine difficulties of execution will thus be avoided.

As soon as the completed construction has reached an aggregate to justify it, the establishment of a maintenance division and the selection of an assistant engineer for its head should be had. Preferably this important step should be taken before it is clearly justified, rather than after.

The vast importance of proper maintenance of roads is beginning at last to be recognized by the states. One, at least, of the reasons for the better maintenance of European roads is unquestionably the absence, to a great extent, from the minds of those in authority over the roads there, of construction problems and consequently the concentration there possible on the minute, tedious, and recurrent details of maintenance. The proper solution of construction problems is not only of interest to almost all, but is also generally accompanied by early and shining rewards. That of the maintenance problem seldom, if ever, is quick or spectacular. Naturally construction problems attract, while those of maintenance seem drudgery. Long, persistent effort in little ordinary matters is demanded of the maintenance division. No greater mistake can, in the speaker's opinion, be made than to expect the maintenance to be satisfactory where the engineer in charge of construction is required to look after it also. This holds good surely above the point when the maintenance expenditures are up to 10 per cent. of its construction expenditures annually.

Division engineers, resident engineers and inspectors will be arranged and needed according to the territory to be covered and the amount of work going on. Probably also, facilities for testing materials will have to be provided and the man in charge of such should report to the head of the construction of maintenance division according to the amount of work being done for each by him; or, he may report to both under some circumstances.

Under the assistant in charge of the surveying and planning will be needed one or more survey parties, draftsmen, calculators, etc., the number of each depending on circumstances, as may readily be seen.

If the amount of work to be done annually is large, scattered and complex, the chief engineer will also need clerical assistance in the shape of a chief clerk or secretary, possibly a purchasing agent for materials for force account work, clerks and stenographers. The purchasing agent may report to the assistant in charge of construction or to the chief engineer directly, as deemed best. The chief clerk should report to the chief engineer directly and the clerks and stenographers to the chief clerk.

The responsibility for the entire engineering department resting clearly on the chief engineer, should be delegated by him only as may be warranted by the exigencies of the situation, and when so delegated, it should be done so clearly and definitely that there can be no doubt nor failure in the mind of anyone having business with the organization in understanding just what authority the subordinates have, at least so far as it concerns their business. There should be left no opportunity for a contractor to say that certain work or materials should be paid for in full "because the inspector or resident engineer saw it go in," nor should a contractor be able to say he was referred from one party to another for a decision on a point and, unable to get anything definite, he "had to do the best he could."

The delegation of authority, especially in a newly organized state highway department, must be made conservatively. The commission and its chief engineer may be new to the work or to the situation, even if the engineer has been trained in similar work elsewhere. Naturally the public will look to them personally for decisions and for locating responsibility, and at first surely demand their personal, physical presence in many cases. The customary requirement for the employment as far as possible of local men for the subordinate positions, at least, will render it advisable for the chief engineer to take on many bright and otherwise admirable young men except that they may be deficient in experience with modern highway work.

The rapid progress in the underlying science and the art of such work, makes it difficult for many beside the chief engineer to keep up-to-date in it, and, therefore, necessary for him to retain, until his subordinates become fully trained as regards the fundamentals of their work at least, sufficient authority, in perhaps a slight excess, for the best results. Further, the speaker has found that far less difficulties with contractors over points arising in connection with their work under the specifications become serious when considered and decided by the chief engineer in person than in cases where such decisions are left to younger and more inexperienced men. In fact many of these points are never raised when contractors know that the chief engineer himself will decide them and can be counted on to abide fairly by the specifications. Of course, unless the commission leaves the decisions provided by the contracts to be made by the chief engineer in the hands of the latter, and supports him in such, those contractors or others anxious to have their claims arbitrated by inexperienced or prejudiced parties may create, by appealing to the commission for decisions, an even worse situation than that in which the authority of the chief engineer's subordinates is not clearly defined or too much delegation of authority has been made to them. But relief from such a situation is from outside the remedies of organization.

From the foregoing may be had an explanation of the speaker's inclination toward the employment in new organizations of inspectors rather than resident engineers on the jobs to be done under him as well as for the retention in his own hands, while chief engineer, or perhaps more of his authority, as such, than in the similar work of many other organizations.

After the final establishment of a definite policy towards its roads on the part of a state; after the proper provision of funds for the carrying out of this policy for at least a reasonably appreciable time; after the public has become accustomed to and a decent majority has settled down to the support of such a policy, and after the employees in the organization, who are likely to perhaps need authority, have become properly grounded and trained to support satisfactorily certain responsibility, then a change or development of the organization above outlined may be, and generally is, desirable for the sake of greater efficiency in the results from expenditures.

We may, therefore, now look at the matter of the organization of a state highway department from the second point suggested at the outset.

Efficiency should, of course, be kept in mind as described in the earlier consideration, but there as may have been hinted at least, it was not the only object, and consequently in the earlier days of the work, the efficiency from a purely financial standpoint may have been obliged to retire at times in favor of what seemed to be for the ultimate public good.

Now considering efficiency alone, the speaker believes that:—

The commission of three may well give way to that of one, or even in the latter case that a competent individual may satisfactorily fill such a position as engineer-commissioner, and the position of chief engineer, as well as the board of commissioners, be avoided. That the position of assistant engineer in charge of surveying and planning may, perhaps, with the central department for his work, be abolished and the work better done under the division engineers assigned to sections of the state. This, however depends entirely upon local conditions and no general rule can be here laid down concerning the point. That it is possible to say the same concerning the assistant engineers respectively in charge of construction and of maintenance, as said immediately above; but in such a case, the necessity for avoiding any serious distraction from maintenance problems by those of construction, should be clearly and constantly kept in mind. That the delegation of more and more of the authority of the chief engineer may be advisable as the training of the subordinates proceeds and the reliance on them is warranted.

With these steps taken at the proper time, the expense for overhead charges should be reduced without depreciation in the value of the physical results and thus the efficiency of the organization increased. Inappropriately taken, they will quickly produce the opposite results on a large scale. The difference between a proper organization and an improper one may be only five per cent. of the total expenditures in the work and this difference can be readily offset many times by the difference in the quality of the physical results, the expenditures for which will probably amount to nearly 90 per cent. of the total expenditures.

The necessity for the proper organization of a state highway department should be recognized by all, but unfortunately the instances of such recognition, or at least the evidence by results of it, seem to be in the minority.

The speaker hopes that the discussion here of the matter, which discussion he has attempted to stimulate by a brief outline of some of his views, may be fruitful in good results.

SLUDGE DISPOSAL.*

By Karl Imhoff.†

Sludge results from all methods of treating sewage. The problem of handling this sludge satisfactorily is just as important as the treatment of the sewage itself, for experience has shown that sludge which has been poorly handled is much more objectionable than the worst sewage.

Wet Sludge.—Fresh wet sludge contains ordinarily more than 90 per cent. water and can be pumped out of the settling tanks in the same way as sewage or water. It would therefore seem a simple matter to get rid of it by pumping it onto low-lying ground and allowing it to remain there with the hope that it would in time become firm. Such treatment is unfortunately almost always without success. Sludge deposited in deep lays does not dry, and the ground remains wet. This treatment is therefore useful only when the sludge is spread out in very thin layers. The sludge can also be discharged into shallow trenches. Under these conditions the sludge dries in some weeks, and can be plowed into the ground for agricultural purposes. The sludge thus becomes used, as it were, for irrigation, just as with sewage. There is the disadvantage, however, that a large area is necessary, and that objectionable odors cannot be prevented.

In the case of cities located near the ocean, the problem becomes simpler. Such cities can send their sludge in ships out to sea and allow it to sink. Since it becomes necessary to carry the sludge a considerable distance from the shore, the cost of this method of disposal is quite high, and it is very probable that some of the cities which have been using this method of sludge disposal could now accomplish the desired ends cheaper by adopting another method of disposal.

In general, one can say with assurance that the cases are very few where it is desirable to dispose of sludge in a wet condition.

Dry Sludge.—As soon as sludge has been properly dried, it has lost most of its objectionable characteristics. In any case, dry sludge can be used as easily for agricultural purposes as other kinds of fertilizer. Its value, however, for agricultural purposes depends more on its physical characteristics than on its fertilizing value.

Dry sludge can also be used for filling low land just as well as ordinary earth. In almost every case this method of disposal is the most economical, if it is not possible to use it for agricultural purposes. Especially with cities which use their refuse for filling is this method of sludge disposal particularly adaptable, because the dry sludge has a volume only about one-fifth of that of the city refuse, and if a city has sufficient ground for dumping its refuse, there will also be sufficient area for the sludge.

In cities where the refuse is burned, consideration should be given to the possibility of burning the dry sludge with the refuse. In such an event, however, there is the danger that the slag will not be so good. In addition to the incineration of sludge, it is not worth considering other methods of artificial disposal of dry sludge; such, for example, as using it for the production of gas or for the reclaiming of the fat contained in it.

As incineration is carried out on a large scale only in one instance (Frankfurt-am-Main) it may be concluded that for the disposal of dry sludge there are left only the two

*A paper read before the International Congress on Hygiene and Demography, Washington, D.C., Sept. 24, 1912.

†Chief Engineer, Sewer Department, Emscher, Genossenschaft, Essen, Germany.

natural methods—its use for agricultural purposes and for the filling of low land.

Methods of Drying.—From what has already been said, we may conclude that the best system of sludge disposal is that in which the sludge is first dried. There are, of course, difficulties connected with this drying.

Science has, up to the present time, interested itself principally in artificial methods of drying. Of first importance in this connection is the pressing of sludge, which has been used for many years in England. The excess water in the sludge is pressed out through filter cloths. Sewage sludge can be pressed only when it is properly treated, for example, with lime or coal powder. This system is a good one, and for the foregoing reason is especially applicable to chemical precipitation works, where the chemicals necessary for the precipitation are added to the sewage. The cost of the system is, however, so high, that, outside of England, it has been used very little.

In comparison with sludge pressing, the centrifugal drying machines used in Germany (Frankfurt and Hanover), are a step in advance, since the fresh sludge is handled without the addition of chemicals. There is, however, the serious disadvantage that the water separated from the sludge is much more objectionable than in the case of sludge pressing. This water contains a very large part of the organic matter of the sludge.

A more natural treatment, and one especially applicable for small plants, is the mixing of the wet sludge with drying matter, which absorbs the moisture. Refuse and street cleanings are especially applicable for this purpose if the sludge is to be used for agricultural purposes.

The simplest of all methods of drying is just to discharge the sludge upon a drying bed, which should consist of 10 in. of porous material with a perfectly horizontal surface, and underlaid with drain pipes laid approximately 12 ft. c. to c. It must not be forgotten that there should be spread over the surface of the bed a thin layer of fine sand, which will have to be frequently renewed.

This simple natural arrangement for drying was formerly very little used, because all attempts to drain fresh sludge were unsuccessful. The sludge must first be made drainable. Without question, this can be done by artificial means, as with the addition of lime or coal powder, in the same way as with sludge pressing. But all these methods of drying are uneconomical.

Automatically, by itself, the sludge becomes drainable while undergoing a process or natural decomposition. We have known this fact for a long time from the "septic tanks," through which the sewage slowly flows, and as a result of being in contact with the decomposing sludge, becomes foul itself and smells. In comparison with these septic tanks, a step in advance was made by separating the decomposing sludge from the flowing sewage, by removing it into a separate tank.

This idea of separate sludge decomposition was, so far as I know, first brought forward by H. W. Clark, of Boston, in the year 1899. It was not possible, however, in the experiments made by Mr. Clark, as well as in other places, to effect, in a separate sludge tank as good a decomposition as with the ordinary septic tanks.

The first success along these lines was made in the year 1906 at the sewage-disposal works of the Emschergenossenschaft in Essen. The type of works referred to are spoken of as Emscher tanks, a special type of double-deck tanks, which consist of an ordinary settling chamber and a sludge-decomposition chamber below, through which there is no flow.

After a short ripening time, there was found in these sludge-decomposing chambers a sludge black in color, and with a slight ordor of tar. In spite of small water content, ordinarily of about 75 per cent., the sludge flowed easily through pipes, and when spread upon a drying bed to a depth of 10 in., became firm and spadeable in a few days. The decomposition was practically odorless, and the sewage flowing out of the settling chamber was totally unaffected by the decomposition of the sludge.

Since we know that it is possible with separate sludge chambers to have the principal advantage of the septic tank, namely, the drainability of the sludge, the septic tanks have lost their importance. Their disadvantages, especially the objectionable odor of the effluent, render them impossible for many purposes. They are to-day suitable only for very small plants.

In most cases, it is desirable to keep the sewage fresh; in other words, to treat it in ordinary settling chambers, and to remove into a separate chamber only the sludge, which requires decomposition, in order that it can be easily drained and dried. It is not to be assumed that the Emscher tank is the only arrangement for bringing about these results. It is possible, without question, to bring about the natural decomposition, which takes place in Emscher tanks, with any properly built tank, filled in the right way with sludge, and operated according to certain principles. I do not yet know of any plants with separate sludge tanks, however, where exactly these results have been obtained. And it seems to me as if all possible scientific methods of bringing about these results, with plants in which the sludge is pumped from the settling tanks to special decomposition tanks, will be much more expensive both for construction and operation.

Practical Tests of Sludge.—In the sense of what has been said, good sludge may be considered as sludge which dries quickly and has no objectionable odor. The following information shows the possibility of easily determining the character of sludge.

Appearance and Odor.—Good sludge is black, and uniformly granular. It moves easily, it has a slight odor of tar or burnt rubber. Bad sludge is grey, full of fibres, soapy, sticky, and has a bad odor.

Adhesiveness.—A white enamel-lined dish pan is filled with sludge and then emptied so that only enough sludge remains to just cover the surface of the enamel. Good sludge will separate itself at once from the water, so that in 10 or 15 sec. the surface is broken up by white lines. Bad sludge sticks to the entire surface. This experiment is especially important because it gives the information at once.

Gas Content.—Newly withdrawn sludge is placed in a measuring glass to a height of 1 ft. After six hours good sludge separates itself from the water which collects below the sludge. With bad sludge, the water collects on top.

Drainability.—Sludge is placed on a sand filter to a depth of 10 in. In the case of good sludge, considerable clear water will drain out in the first few hours. In three days, during dry weather, it will be firm and spadeable. With bad sludge, only a small amount of water drains out of the sludge, and this takes place very slowly.

Conclusions.—The two best methods of disposal of sludge are (1) its use for agricultural purposes, and especially (2) filling of low land. In both cases, the sludge must first be dried, and this is best effected upon a drying bed after the sludge has decomposed in an inoffensive odorless manner in a separate tank through which sewage does not flow.

GAS-ENGINE RESEARCH.

On Thursday, January 30th, Professor B. Hopkinson delivered a lecture at the Royal Institution, London, England, on "Recent Research on the Gas-Engine." In his opening remarks Professor Hopkinson pointed out that during the last thirty years, though expectations had been realized with regard to the economy secured in the gas-engine as compared with the steam engine, as regards development in the way of size, anticipations had not been realized owing to limiting factors which were not foreseen many years ago. The Selandia had engines of 2,500 horse-power, but that was developed in sixteen small cylinders. On that scale large modern vessels would require from 200 to 250 cylinders, which was altogether out of the question. The rapid progress made by the steam turbine, which was now being made in 40,000 horse-power units, was in great contrast to the development of the gas-engine, which engineers found to be hampered by serious difficulties. It was the province of engineering science to investigate such conditions as these, and it was to the credit of this country that it had contributed largely to the advance in gas-engine research in recent years. That had largely been the result of the work of the British Association Committee on Gaseous Explosions.

In order to explain the nature of the difficulties encountered, Professor Hopkinson described the ordinary gas-engine cycle, and pointed out how, in it, waste might be saved by increasing the expansion. In order that that might be accomplished, it was necessary to compress to a greater extent, with resultant increase of pressures on firing. That, however, necessitated a much more heavily built engine. The flame of gas in the cylinder parted with its heat at a great rate, and the metal had to be kept reasonably cool to ensure satisfactory working. In order to demonstrate what went on inside a gas-engine cylinder Professor Hopkinson fired, inside a closed vessel provided with a glass window, a mixture of gas and air identical with that consumed in a Bunsen burner. Whereas the Bunsen flame was practically non-luminous, the flame in the closed vessel was seen to be luminous. The pressure in the vessel rose rapidly and fell off quickly, but more slowly than it rose.

To determine the extent of the heat-flow to the walls of a vessel in which an explosion took place, a vessel lined with a continuous spiral of insulated copper strip had been employed, and the varying electrical resistance of the strip of copper had been recorded, the pressures resulting from the explosion being recorded simultaneously. The heat-flow was found to be about 10 calories per sq. cm. per second, which was about the rate of radiation from molten steel. That flow of heat caused the chief troubles in the gas-engine. To deal with it the water-spaces had to be exceedingly large compared with the working space, while they were also extremely complicated. The exigencies of design further rendered a uniform heat-flow an impossibility, so that some parts were much hotter than others, with the result that bad stresses were set up, and castings often broken. Although large differences of temperature were thus most undesirable, they were essential to the maintenance of the necessary heat-flow. Unless this was sustained some part might become sufficiently hot to ignite the gas prematurely.

Till recently it was imagined that the heat-flow was due chiefly to convection and conduction. It had now been shown to be greatly due to radiation. Gaseous molecules were in constant vibration, and when, in the combustion of the gas mixture, chemical combinations took place, the vibrations were intensified, with resulting increase of radiation. Explosion experiments had been made in closed vessels with black interiors, absorbing radiant heat, and again in vessels polished inside. The effect in the latter case was to retard the heat-flow, and consequently the rate at which the pressure fell. Cooling was roughly only two-thirds as fast with the polished as with the black surface. Radiation during combustion had been measured by a platinum grid placed outside a fluorite window in the wall of a closed vessel, and it was found that about half the heat of combustion in the vessel was radiant heat. As the volume increased the radiant heat increased. That had been proved by David, who got twice the amount of radiation at the window of a vessel polished inside that he did when black, the polishing being equivalent to an enlargement of the volume.

The difficulties were, therefore, cumulative as regards large gas-engines. In the larger sizes, owing to the increased dimensions, large differences of temperature were necessary in the castings, in order that the heat-flow should be sustained; and as the increase of the volume of the flame added further to the heat to be dealt with, still greater temperature differences had to be employed.

MEXICO'S OIL PRODUCTION.

The oil industry is rapidly developing in Mexico, and this has now begun to assume proportions of such magnitude and is destined to be so far-reaching in its effects on the world's commerce generally that it is worthy of closer attention.

The total investment in this industry is now upwards of $80,000,000 gold, and its development has practically all taken place within the last five or six years. Broadly speaking, the petroliferous zone has been found to extend for 250 miles along the Gulf coast and fifty miles inland (12,500 square miles), with the port of Tampico near the centre. The present production (though many wells have been closed after testing, pending the development of transportation facilities) is conservatively stated at 214,000 barrels, of forty-two gallons each, per diem. Not 10 per cent. of the wells drilled have failed to show oil, and the average yield per well is 2,000 barrels per day, as against 42.56 barrels in California, which is the largest of the United States oil fields. It is true that the average yield is greatly increased by the production of a few very large wells, but these latter are situated many miles apart with innumerable "strikes" between, so that this average will probably be maintained as development progresses.

The world's total production in 1911 was 345,000,000 barrels of forty-two gallons, or 53,000,000 tons. The present potential production in Mexico is 78,110,000 barrels, and this from not more than a hundred wells. According to the latest figures to hand, Mexico has jumped from a production of 1.02 per cent. of the word's total in 1910 to a potential production during the present year equal to over 22½ per cent. of the total for 1911. This is second only to that of the United States and 8,000,000 barrels more than Russia produced in 1910. In accomplishing this less than 1 per cent. of the proven oil area has been prospected, and the country has only to increase its production threefold to become the largest producer in the world, a position which, with the same success as has been experienced in the past two years, she may very speedily attain, and even then not have tapped one-twentieth of her petroliferous zone.

The chief difficulty in the way of this development lies in the lack of transportation facilities. The total number of oil tankers registered at Lloyds is below three hundred, whereas, allowing for the present ratio of increase, it is estimated that it will soon take three times that number to transport the oil supply of the Gulf coast alone. In anticipation of this most of the shipyards in Europe are congested with tankers under construction.

CALCULATIONS FOR THE CAREENING OF A CAISSON.

By Leonard Goodday, C.E., M.E.*

The caisson, as illustrated in the diagram below, was constructed a few years back for the entrance to a "dock basin" in the east.

A caisson, as with any vessel, has to be built with great accuracy, so that when its keel is horizontal the vertical planes, both longitudinally and transversely, are square to one another, i.e., the vertical plane through the centre line from stem to stern is at right angles to the vertical plane athwart the beam when it is in equilibrium as a floating body. This is so when its centre of gravity is in the same vertical line with the centre of gravity of the fluid displaced. When it careens or gives a list to leeward from any external pressure, these centres of gravity alter their position, and if a vertical line is drawn through that of the fluid displaced until it meets the axis of the body, then that point will be the meta-centre of this body. Stability is always maintained when the meta-centre is above the centre of gravity, and unstable if below.

When being moved from the "Chamber" or any other place to the entrance, a caisson is liable to encounter fresh winds, and it has been known to have too much of a list, which makes it very troublesome to place in position. The hydrostatic pressure will assist in making it come to its bearings when in place, when the water is being let in for sinking it.

These conditions being fulfilled, an approximate calculation is made before the construction takes place to determine the wind pressure required to careen the caisson to an angle, causing the flood openings to be just awash.

Now, by calculation and measurement, the angle in this case will be $1^\circ\ 15'$ to the vertical.

Height of meta-centre above the centre of buoyancy (C.B.) equals moment of inertia (M.I.) of water plane $58' \times 23'$ divided by the displacement in cubic feet equals

$$\frac{\text{Length} \times \text{Beam}^3}{12} \div 454 \text{ tons} \times 35$$

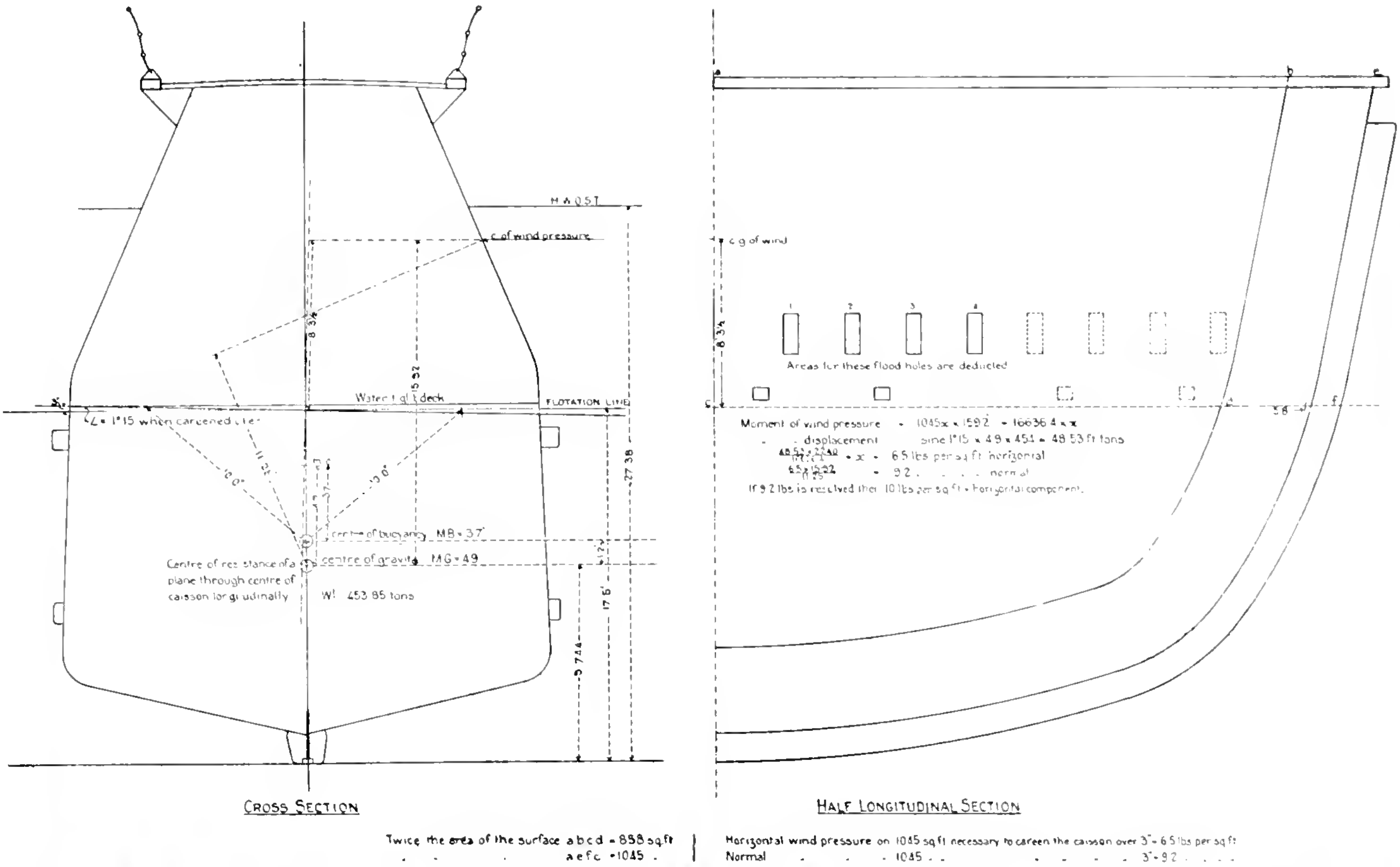
$$(35 \text{ cu. ft.} = 1 \text{ ton sea water}) = \frac{58 \times 23^3}{12 \times 454 \times 35} = 3.7 \text{ M.B.}$$

Height of C.B. above C.G. $= 1.2$ ft.

Height of meta-centre above C.G. $= 4.9$ M.G.

Height of centre of wind pressure (when horizontal) above the centre of resistance $= 15.92'$

Moment of wind pressure $= 1{,}045$ sq. ft. $\times\ 15.92' = 16636.4$



Caisson at Basin Entrance at Dockyard—Diagram Showing Wind Pressure Necessary to Careen Caisson Over 3 Inches.

The righting moment at an angle of $1^\circ\ 15' = \sin 1^\circ\ 15' \times$ M.G. $\times$ displacement $= .0218149 \times 4.9 \times 454 =$ 48.53 ft.-tons A

Total pressure of wind on the side of the caisson to balance A $= 16636.4 \times x$ (when x = pressure per sq. ft.)

Therefore, the horizontal pressure of wind necessary to careen the caisson $1^\circ\ 15' = x = \dfrac{48.53 \times 2240}{16636.4} = 6.5$ lbs. per sq. ft.

If normal, the pressure becomes $\dfrac{6.5 \times 15.92}{11.25}$ (11.25 being the leverage of wind $= 9.2$ lbs. per sq. ft.

* Late of the British Admiralty.

If 9.2 is resolved, the horizontal compound = 10.0 lbs. approximately.

According to Molesworth, this nearly equals a very high wind, which would be from 7.8 to 9.9 lbs. per sq. ft.

Under these conditions the caisson will practically remain in equilibrium under all conditions of weather.

BUILDING GRADES AS GIVEN BY THE CITY OF EDMONTON.

By C. C. Sutherland.*

In Edmonton, as in other cities, we find people building in advance of local improvements, and in order that their door-steps and lawns may coincide with the finished street, it is necessary for the City Engineer to give each builder the elevations at which the future improvements will be constructed.

With these elevations marked on grade stakes at the front of his lot, the builder is then in a position to construct his house and finish off the lawn and sidewalks at the proper elevation to fit in with the completed street.

It is of great importance, then, having once given the grade to the builder, that this grade is not changed, and that future construction will go in at the elevations given, and not above or below the improvements made by the builder.

In a municipal office where the grades on a street may be established by one person and set in the field by a second, while with a continually changing staff of engineers, the construction of the permanent improvements on a street may be laid out by a third man, to say nothing of the chance that the builder himself does not carry the grades from the stakes correctly, it is very difficult to prevent errors from creeping into the work, and it is to reduce these to a minimum as well as locate at once where any error has occurred, that this city has adopted the following system:

A complete building grade is made up of two parts, the application and the certificate. The application for a building level is made by the owner or his agent at the office of the City Engineer, giving the location of his lot, by the street boundaries as well as the lot and block number. This is a good check and has saved considerable trouble, as the public are more familiar with their street name than lot numbers. The application is then signed and a fee of five dollars collected before any work is undertaken.

The certificate for a building grade is made a complete record of the work done, starting with the office down to the marking of the grade stakes.

When a building grade has been given off a profile, it is good practice to mark the building grade number on the plan above the profile, together with the elevations to be set in the field. This will act as a caution point and immediately check any intended change in grade unless such change was absolutely necessary. The number refers you to the detail description in the record book. Some engineers keep a map marked up-to-date with each building grade set, but we have found the method of marking the profile much more convenient.

The elevations are now given to the instrument man to set in the field. Here it will be well to emphasize the importance of marking stakes. It is no exaggeration to say that 90 per cent. of the mistakes made in connection with building grades are made because the builder has not read the grade stakes correctly. When a grade is set by a stake not at the elevation of the actual grade the marking should read to give the exact idea of the elevation, such as 1'-0" above grade or 1'-6" below grade.

The grade given to the builder is the property grade or the elevation at which the finished boulevard, or walk, will be constructed adjoining his property. It has been found desirable to print an explanation of the term "property elevation" on the back of the certificate.

When questions come up in grade work, we want to know who set this particular grade, when it was set, and all other detail information connected with it. For this purpose the page and number of field work is given on the certificate, although this information is of no use to the builder.

The attached form is a combination of the application and certificate for building levels used in this city. They are bound in field book size of 100 alternate white and yellow

*Roadways Department, City Engineer's Office, Edmonton.

CITY OF EDMONTON FORM E. D. 3
ENGINEERING DEPARTMENT

APPLICATION FOR BUILDING LEVEL

Date May 16 / 1912 No. 675

I hereby make application for building level on North side of College Street between First St. and McDougall Ave. for lots 10 Block 4

Plan R. L. 6, and agree to pay $5.00 for the same. J. J. Smith
OWNER or AGENT

Mailing address 425 Sixth St.

CERTIFICATE FOR BUILDING LEVEL

Date set May 17 / 1912 F.B. No. 190 Page 50 Set by W. Milne

STATION	LOT	BLK.	PLAN	PROPERTY ELEV.	ELEVATION SET	STAKE MARKED	REMARKS
S.E. corner	10	4	R.L.6	240.20	241.20	1-0 above grade	nail in stake
S.W. corner	10	4	R.L.6	240.80	240.80	grade	nail in stake

Bench Mark No 76 At N.W. corner College and McDougall

Elevation 243.76

CITY ENGINEER

pages, the white pages being perforated so that they may be taken out and sent to the builder. By using carbon paper the yellow page is made a record.

On receiving this certificate the owner gets all the information connected with the building grade and is in a position to have this grade checked if at any future time he thinks his grade has been altered, while the Engineering Department have a complete book of record of all the building grades set in the city.

BRICK PAVEMENTS FOR COUNTRY ROADS.*

The use of brick for surfacing country roads is rapidly gaining favor with highway engineers and the general public.

In 1909, the New York State Highway Commission decided to use a more permanent form of construction than macadam for the main highways leading into the larger cities, as any of these macadam roads were in bad condition, due to heavy traffic and lack of systematic repairs.

Experience has shown that macadam roadway under heavy traffic, either wagon or automobile, is not economical, mainly on account of the high cost of maintenance. The New York State Highway Commission, after extensive investigation, decided to use brick construction on their main highways; and, as a result, in 1910, about 20 miles of brick highways were constructed in the vicinity of the city of Buffalo. These roads proved so satisfactory to the travelling public, as well as to the Maintenance Department (the cost of maintenance being so low) that the mileage of brick roads in the vicinity of Buffalo at the present time is about one hundred miles, and this mileage will be greatly increased during the year 1913 if the present plans of the Commission are carried out.

These brick highways connect the city of Buffalo and Fort Niagara (at the mouth of the Niagara River) by way of the city of Niagara Falls, and reach out, with Buffalo as a centre, to all points of the compass; and I feel confident that it will not be long until every important highway leading into Buffalo will be of brick construction. This is also true of many of the larger cities of New York State, and the villages are now adopting brick construction under State aid.

The process of manufacturing brick for paving purposes has become more scientific as the demand for brick has increased and the methods of construction improved.

Streets built twenty to twenty-five years ago were paved with wire-cut bricks of the same size as building brick. Later, re-pressed brick of the small size were used. When the constructing engineer asked for a projection on the brick which would separate each course so as to allow the filler to enter and bind the bricks, the manufacturers placed their trade mark, in the form of raised letters, on the side of the brick. Later, more pronounced lugs were demanded; these raised letters, or lugs, require a re-forming of the brick in stamping machines (erroneously called a re-pressing machine), and as a consequence the so-called re-pressed brick with lugs drove the old wire-cut out of the market. The size of the brick was also increased to that of the present block.

Highway engineers still demand a block with lugs, and in 1910 a wire-cut lug-block was placed on the market for their consideration.

The brick with its lugs being cut by a machine at one operation shows, consequently, all lugs of uniform size, while on a re-pressed block many of the lugs are malformed or a part remains in the mould.

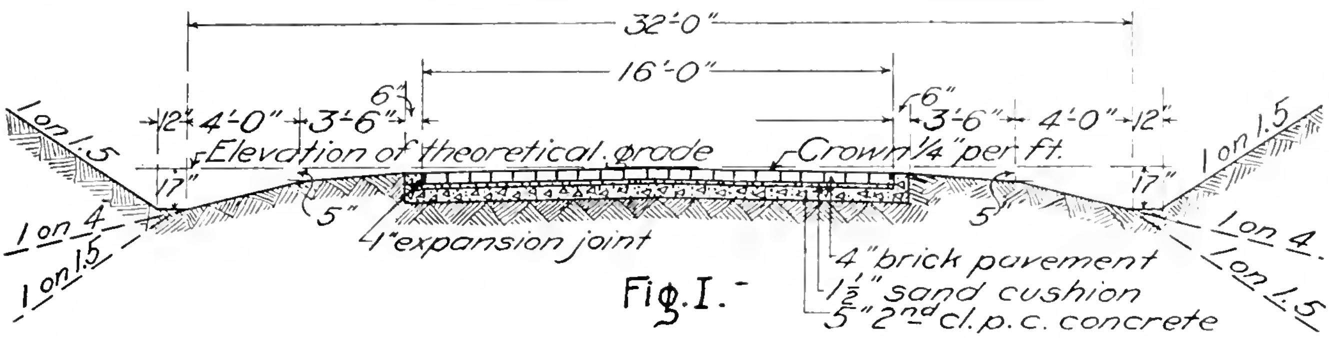


Fig. I.

Fig. 1 shows the New York State standard section for a brick country road, which calls for 16 ft. of brick surfacing, 1½ in. sand bed (this will be increased to 2 in. in 1913), and a foundation of 5 in. thick of concrete mixed 1 to 2½ to 5.

The brick surfacing is confined by a concrete edging 6 in. wide, flush with the pavement, and separated from the pavement by a well-defined expansion joint ⅞ to 1 in. wide.

For surfacing wider than 16 ft., these longitudinal expansion joints are increased proportionally to the width of pavement. No transverse expansion joints are used. In 1910, transverse expansion joints, placed fifty feet apart, were used with disastrous results, the blocks having become loose and crushing on each side of the joint. The shoulders or wings on each side of the edging are of earth, 7 ft 6 in. wide, making the width of the roadway 32 ft. between ditches; normal ditches are 1 ft. wide and 17 in. below the centre of the road or theoretical grade; back slopes of ditches, 1 on 1½; if necessary for proper drainage to

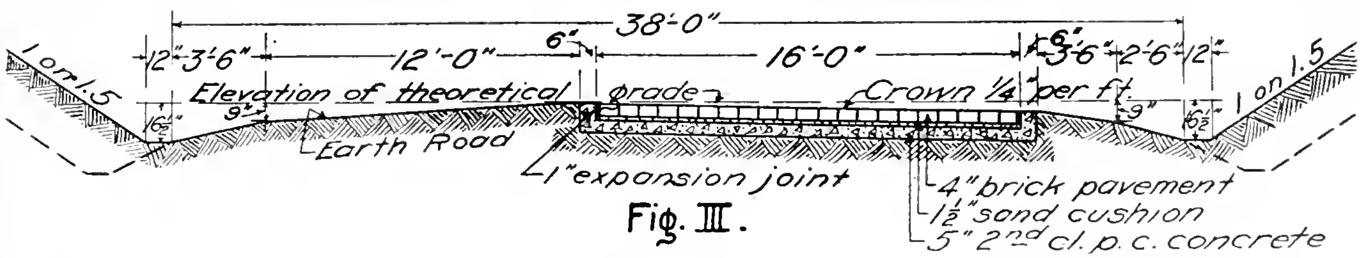


Fig. III.

* Presented at the Cleveland meeting of Section D of the American Association for the Advancement of Science by William C. Perkins, Resident Engineer, Department of Highways, State of New York, Niagara Falls, N.Y.

deepen the ditches or on embankment, the slopes are made 1 on 4 or 1 on 1½, but if the steeper slope is used, grade-rail is necessary. The crown of the brick section is ¼ in. per foot.

Fig. 3 shows a special section, combining a brick and earthen road, used on the highway between Niagara Falls and Buffalo. This is very similar to the section used on the roads around Cleveland. This section has 16 ft. of brick surfacing, with necessary edging and wing on one side of highway, and a 12 to 16 ft. earthen road on the other side.

Fig. 12.

This highway has just been constructed, having been opened for traffic on Christmas Day, and is 17 miles in length between the city lines. Fifteen miles of this highway is laid with wire-cut lug-blocks, the other two miles having been built in 1911 of re-pressed block. The traffic, especially automobile, will be very heavy. No traffic census has been taken, but on a Sunday afternoon (two weeks before the road was opened), at a time when it was necessary to make several bad detours, 256 automobiles passed a specific point in one hour.

The surface drainage is carefully examined, and concrete culverts used for the larger waterways and cast-iron pipe for the smaller.

The construction of a brick highway is in charge of a construction engineer, with a force of inspectors, and he is held responsible for the proper construction of the road and for all lines and grades. The method of construction is as follows:—

The road is first rough-graded, and when sufficient material has been excavated the sub-grade is rolled with a self-propelled road roller until it is thoroughly consolidated. Any weak spots that may develop are dug out and properly taken care of by either a sub-base course or a tile drain.

Fig. 15.

In some instances a combination of the two are used. The surface is then trued up by means of picks and shovels to conform to the cross-section.

The concrete used for base is made of 1 part of Portland cement, 2½ parts of clean, approved sand, and 5 parts of crushed stone or screen-washed gravel. The mixing is done by machines of the batch type.

Great care is used in having the concrete base smooth and of the same cross-section as the finished template, which rests on the edging forms, and is drawn as the work

Fig. 13.

Fig. 16.

In the preparation of plans for a brick highway on New York State work the designing engineer carefully examines the surveyed plan, making a new location of the centre if, in his judgment, it will improve the alignment; avoids all sharp turns, taking new rights-of-way if necessary. Easy grades are designed for the main highways, which often necessitates the cutting down of hills and the filling in of hollows.

progresses. Upon this concrete foundation a bed of clean, dry sand is laid, which is 1½ in. thick when pavement is complete. This sand bed is rolled with a hand-roller weighing about two hundred pounds, and then brought to the exact form and crown by means of a template of the proper shape resting on the edgings, or on scantlings embedded in the sand. The template is drawn forward and backward immediately in front of the brick-laying, so that the sand cushion is maintained constantly at the proper cross-sections.

On this sand bed the bricks are laid on edge at right angles to the edging, except at road intersections, where they are laid at such angles as directed by the engineer. All longitudinal joints are broken by a lap of one-half the length of the brick. The bricks are laid in close contact with each other by experienced bricklayers, with the lugs in the same direction.

After a stretch of pavement is laid it is inspected, and all soft, broken or misshapen bricks are removed. Any brick slightly spalled or kiln-marked is turned over, and, if the opposite face is acceptable, it is allowed to remain in the pavement, otherwise it is removed. Any unevenness or irregularities of the surface, after rolling, is removed by means of ramming.

The pavement is then thoroughly wet by sprinkling and the filler applied. This filler and its proper application is one of the essentials of a good brick pavement. The filler used is composed of one part Portland cement and one part sharp, clean sand, mixed in small quantities and care- object of a filler is to make the sur[illegible], [illegible] undue wear of the individual block, and to [illegible] the blocks together in a monolithic structure. The joint should become part of the pavement, and, as near as possible, of equal strength with the brick, all expansion and contraction to be counteracted by the use of well-constructed longitudinal expansion joints.

In constructing longitudinal expansion joints, two clapboards, or wedge-shaped boards, are used in each joint while the brick surface is being rolled and the cement filler applied. After the filler has been applied the boards are removed, the outside board being removed first in order to avoid loosening the blocks adjacent to the joint. The joint is then thoroughly cleaned to the full depth of the block and the pitch or asphaltum applied.

On all sharp curves we find it an advantage to use a wider expansion joint on the outside of the curve, as the tendency of the pavement is to move in that direction and away from the inside edging.

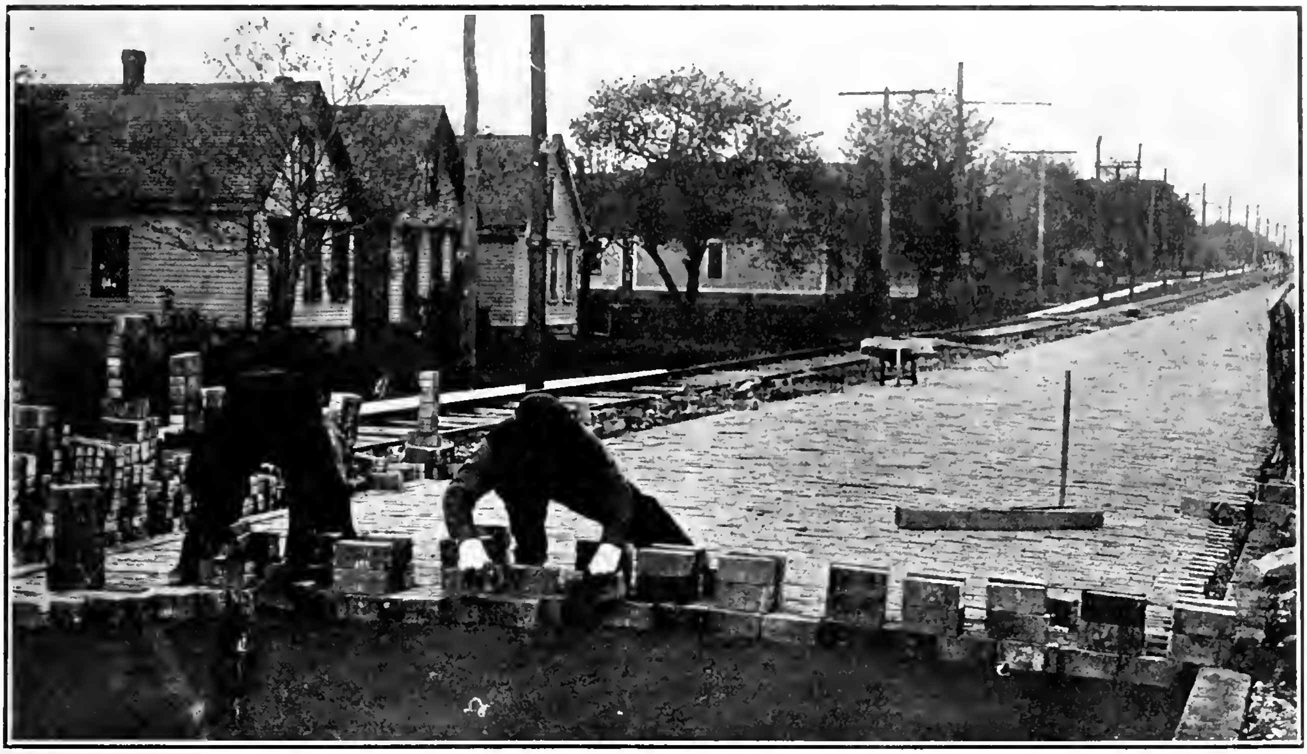


Fig. 14.

fully applied to the brick surface by means of scoop-shovels and swept at once into the joints by means of push-brooms or squeegees.

Before the cement has attained its initial set, the same portion of the work is gone over a second time, using the same mixture of grout, care being taken in each instance to thoroughly fill all joints flush with the top of the brick. Blocks with imperfect lugs, in order to secure flush joints, a third, fourth or fifth coat of grout is often necessary.

When sufficient time for hardening has elapsed, a coating of sand is spread over the whole surface and kept moist during the heated period of the day, in order to obtain as uniform a temperature as possible while the grout is setting. The roadway is then allowed to remain absolutely free from disturbance or traffic of any kind for a period of ten days. Some engineers advocate a weaker grout than a 1 to 1 mixture; others, a pitch filler, but my experience has been that better results can be obtained with a 1 to 1 cement filler, properly mixed and properly applied. The

All bricks are subject to tests for abrasion and impact, according to the standard methods prescribed by the National Paving Brick Manufacturers' Association. In 1910 and 1911, when the old form of rattler was used, a block which lost over 19 per cent. was rejected. In 1912, all tests were made on the new standard rattler, and all blocks which lost over 24 per cent. were rejected. Samples are taken at the roadside from every 200,000 block, or from any shipment which may be questionable.

As to the cost of brick paving on country roads, this varies according to local conditions. Highway contractors made use of various labor-saving devices to decrease the cost of construction. All unloading of stone and sand is done by machines. Many contractors are using traction engines for the hauling of material; some use small-gauge tracks with locomotives and cars. A modern concrete mixer is very necessary.

From data obtained from various roads a fair estimate of cost would be as follows, based on—

	Per hour.
Labor	$0.17½
Teams	0.50
Foreman	0.35

No office or incidental charges estimated.

Labor per square yard, brick paving in place, exclusive of concrete base:—

Unloading and piling brick	$0.035
Hauling brick one mile	0.040
Laying and rolling	0.070
Making sand cushion	0.020
Grouting	0.028
Expansion joints	0.007
Culling, replacing, etc.	0.005
Total labor, per square yard	$0.205

Fig. 17.

The manipulation of the concrete for the base varies from 40 to 60 cents per cubic yard, using batch machines and depending on gravel or stone concrete. The average bid price for brick pavement in western New York, including concrete base 5 in. thick, but excluding excavation, is $2.05 per square yard.

The brick highways constructed by the State of New York have given general satisfaction to the travelling public. Brick is the ideal pavement for heavy traffic; is smooth to the automobilist; originates no dust; is thoroughly sanitary; and, properly constructed, will be an inheritance appreciated by our children's children.

AMERICAN STATIONARY ENGINEERS.

The following is an abstract of the report made lately to the president of the National Association of Stationary Engineers by the National License Committee of the United States:—

The Indiana bill, endorsed by all of the State engineers' organizations, provided for a board of examiners of four members, the chief examiner acting as president, and the examining, licensing and classification of engineers and firemen. The examination fee is $3, and the fee for renewals, to be made annually, is $3, thereby making the department self-sustaining. The examintion board is authorized to reduce the fees when they exceed the expense of operating the department. This bill was approved.

The Oregon bill, which combines an engineer's license law and a boiler inspection law, is a model of its kind and framed to meet present-day requirements. It provides for a board of rules of four members, a chief inspector, ten deputy inspectors and a secretary; all inspectors to be selected by the merit system. The fee for internal boiler inspection is $5, and that for inspection while in operation, $2. It further provides for the examination, classification and licensing of engineers and firemen. The application fee is $1, and the license is issued for an indeterminate period, to be revoked for cause and renewed upon affidavit, when destroyed or lost. Penalties of fines and imprisonment are provided for employers and engineers violating the law. The annual renewal and license fee is eliminated. This, together with the requirement that the engineer keep a daily record of the condition and repair of all boilers carrying over 251 pounds pressure are two very important features that should commend the bill to the favorable consideration of both the steam user and the engineer. This bill also was approved.

Delaware reported that, having made four attempts to secure a State law, it may compromise on an enabling act, thus giving cities the right to enact local ordinances. Mr. Case, of New Jersey, has secured over 10,000 signatures to his petition for a license law, with good prospects of passage at the coming session of the legislature. Mr. Lee, of the New York license committee, will call a meeting later to determine the future policy of that committee. The Maryland committee reports progress on its proposed bill. South Carolina, which some years ago made a futile effort to secure a law, again desires to take up the matter, and will negotiate with the National License Committee to that end. The prospect of presenting a bill to the Pennsylvania legislature during the coming session is likely.

Mr. Coughlin reported that as the Kentucky legislature would not meet until 1914, license work in that State would be deferred until that time; that prospects in Indiana, with all engineer's organizations united on a bill, looked favorable for its passage at the coming session of the legislature.

Mr. Wirmel reported favorably on the Michigan, Illinois and Wisconsin state bills and on the Aberdeen (S.D.) ordinance; that the work in Ohio to broaden the scope of the boiler inspection law and to eliminate the engineers' license renewal fee would be submitted to the legislature.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

JAMES J. SALMOND, Managing Director
JOHN A. CAMERON, B.Sc., Editor
A. E. JENNINGS, Advertising Manager
THOS. H. HOGG, B.A.Sc., Associate Editor
P. G. CHERRY, B.A.Sc., Circulation Manager

Present Terms of Subscription, payable in advance
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (7s.)	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, FEBRUARY 27, 1913. No. 9.

CONTENTS OF THIS ISSUE.

OUR POTENTIAL WATER POWERS.

Nature has endowed Canada with vast resources in the water powers so thickly scattered throughout the country. These sources of power, by far the greater proportion of them still in potential form, will in the near future form one of the most valuable natural assets we have.

Cheap power is one of the fundamental requisites of a successful industrial community. With power available at a low cost, whether this be due to cheap coal, crude oil, gas or favorable hydraulic conditions, transportation conditions will usually adjust themselves.

Pennsylvania's supremacy in the iron and steel field is due to her vast supplies of coal and iron ore. The New England States, on the other hand, have developed as a result of the available water powers.

Ontario, unfortunately, has no local coal supply, but Nature has been kind in the ample provision she has made for the province in the many water powers throughout the province. These water powers, as the present sources of fuel become exhausted or their supply is restricted, will become more and more valuable. It is probable that the next decade will see a tremendous increase in hydro-electric developments in Central Canada. It is safe to predict that within twenty-five years there will be at least three million of electrical horse-power in daily use from the water powers of the Province of Ontario alone.

For many years to come it is probable that Ontario, and perhaps Quebec, will see more activity in the development of water powers than other parts of the Dominion, due to the distance necessary for transporting coal, and to the large number of cheap and available developments.

British Columbia is also most advantageously located with regard to possible hydro-electric power, and, no doubt, many of these, additional to those already used, will be exploited. With the vast coal fields of that province, however, there is not the same driving necessity for the immediate development of the water power resources.

If these water powers throughout the country are to be used in the best interests of the public, great care must be exercised in the allotment of franchises for their use. The several provincial governments and the Federal Government must be exceedingly cautious in granting rights of development to private corporations. Development should only be allowed with stringent regulations, and under short-terms leases.

PRECISE SURVEYING.

It is almost always a matter of satisfied and gratifying pride to the engineers, a subject of bewildering surprise to laymen, that tunnels starting miles apart, with intervening hills and mountains in between, can be made to meet as exactly as they do. Curving tunnels or straight makes no difference with the way they finally slap up against each other, squarely, face to face, and on the same level. When we consider the labor and money lost if they do not meet, the importance and responsibilities of the preliminary surveys that lead to the final alignment of tunnel then take on their true value.

In an article in this issue by Mr. Busfield, engineers not acquainted with the care exercised in this kind of work will find an able and interesting description of it in

its details. It is the last word in modern precise surveys. Everything, from the standardizing of tapes, making allowance for temperature changes and elevation of measurements, and finally taking only the mean of several readings, each read to one thousandth of a foot, was done. The instrument work for angles and levels was just as carefully carried out to the last practical and known point of human carefulness and instrument accuracy. After reading it, it is with the utmost confidence one looks ahead to Mount Royal Tunnel, and its several workings finally joining up perfectly true and exact as per plans.

GOOD ROADS.

A Good Roads Exhibition, the first of its kind in Canada, is being held in the Exhibition grounds, Toronto, the 24th inst. to March 1st. The Ontario Good Roads Association is also holding its annual meeting the 26th, 27th and 28th of this month in the same city. In connection with the present agitation for good roads, an agitation which extends from coast to coast of Canada, and which is gaining in strength and popularity with all classes, it is, perhaps, well to note the start of the movement. As far as we can learn, the Ontario Good Roads Association, organized in 1894, was the first association actively trying to interest the people in better roads. They instituted quite a campaign of education on it, and by 1900 a considerable number of townships had abolished statute labor, and road-graders and machinery was superceding former modes. To-day, provincial and federal aid for highways in considerable amounts is becoming part of the financial expenditure of Canadian legislatures. Moreover, there is at present before the Ontario legislature a bill regulating the width of tires, etc., on vehicles, which ought to greatly help in economically maintaining and improving the general state of roads. Heavy loads and narrow tires, while they have been for years most destructive to our roads, do not appear to have so impressed the people, and seem to have passed unnoticed in their destructiveness, as far as producing legislation has gone. It is a cheerful sign to see this bill before the House, and let us hope it will pass.

This paper would like also to congratulate the Ontario Good Roads Association on its untiring work for years towards better roads. Below is a copy of the programme for their general meeting.

PROGRAMME OF ONTARIO GOOD ROADS ASSOCIATION.

ELEVENTH ANNUAL MEETING.

Toronto, February 26th, 27th and 28th, 1913.

First Day.

Morning Session, 10 a.m.

1. President's Address—T. L. Kennedy.
2. Report of Executive—George S. Henry.
   Report of Committee on the Constitution.
3. Appointment of Committees.
   Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

1. Address—H. C. Hocken, Mayor of Toronto.
2. Address—Colonel Henry Brock, President Toronto Board of Trade.
3. Address—Sir Edmund Walker, President Canadian Bank of Commerce.
4. Address—C. J. Foy, K.C., Perth.

Inspection of Machinery Exhibit.

Second Day.

Morning Session, 10 a.m.

1. "The Township Road System," D. W. White, Clerk of Middleton.
   Discussion.
2. "County Road Organization and Construction," W. A. McLean, Chief Engineer of Highways for Ontario.
   Discussion introduced by Dr. C. O. Fairbank, of Petrolea.
3. "Technical Course in Highway Engineering," A. T. Laing, Toronto University.
   Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

1. Address—Hon. J. O. Reaume, Minister of Public Works for Ontario.
2. "Road Maintenance," Dr. L. I. Hewes, Engineer in charge of Maintenance Division, United States Office of Roads, Washington, D.C.
   Discussion introduced by E. A. James, County Engineer for York; John Roger, County Engineer for Perth, and James L. Tailor, County Road Superintendent for Wentworth.
3. "Stone and Gravel Roads," E. R. Blackwell, County Engineer for Leeds and Grenville.
   Discussion introduced by T. V. Anderson, County Road Superintendent for Lennox and Addington; R. H. Fair, County Road Superintendent for Frontenac; R. H. Jupp, County Road Superintendent for Simcoe.
   Inspection of Machinery Exhibit.

Third Day.

Morning Session, 10 a.m.

1. "Town and City Streets," G. G. Powell, City Engineer, Toronto.
   Discussion introduced by T. H. Jones, City Engineer, Brantford, and J. C. Gardiner, C.E., Niagara Falls.
2. "Steel Bridges," C. R. Young, C.E., Toronto.
   Discussion introduced by H. J. Bowman, C.E., Berlin.
3. "Concrete Bridges," Charles Talbot, County Engineer for Middlesex.
   Discussion introduced by R. W. Farley, County Engineer for Carleton.
   Inspection of Machinery Exhibit.

Afternoon Session, 2 p.m.

Reports of Committees.
Election of Officers.
Unfinished Business.
Meeting of Executive.

STORM WATER DISCHARGE.

By R. O. Wynne-Roberts* and T. Brockmann.†

(Continued from last week).

Impermeability of Surface.—It is palpable that rain falling on the surface of the earth will be absorbed in some proportion to the permeability of the soil, etc. Very little rain will run off sandy ground, but if the ground is hard clay, or close-grained rock, more will flow over the surface and be drained away. If the ground is already saturated, most of any rain falling upon it will flow off by gravitation to the lowest point. In the case of intense rainfall, the ground is unable to absorb the same proportion of water as it would if the rain fell in gentle showers, and consequently a larger percentage of it is drained away.

Following this method of reasoning, it will be observed that in the case of towns with well-paved streets and yards, and houses built closely together, the storm water discharge will naturally be expected to be greater than where the streets are constructed of more absorbent material or where the streets are not made at all. Where the buildings are further apart and the degree of permeability is greater, the discharge to be dealt with will be less.

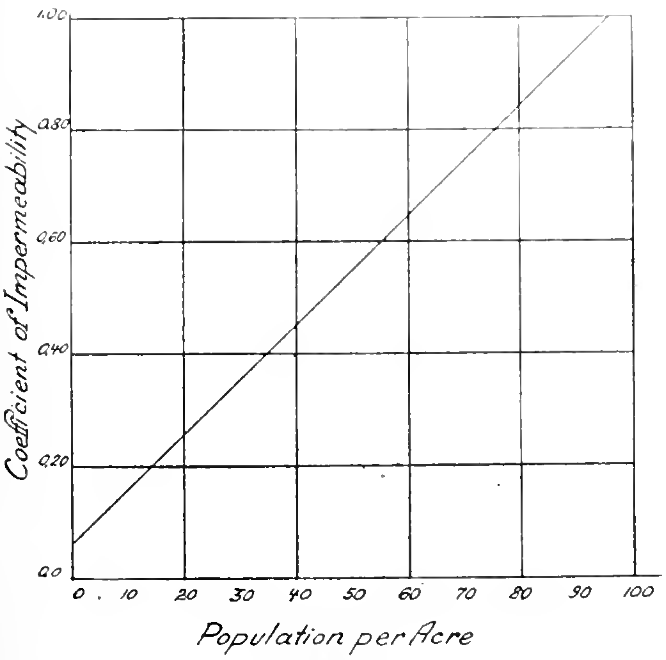


Fig. 1.

Mr. Wallington Butt, in a paper which he read in 1907 on the subject of "Calculation of Storm Water Discharge," rightly stated that the extent to which a town area has been built upon is, in some measure, also an indication of the impermeable area; in other words, the density of the population bears some relation to the area of impermeable surface in that district.

Mr. Wallington Butt, at the same time, submitted a diagram which he considered would assist to ascertain this factor, and this diagram is now reproduced for our present purposes. It is well, however, to point out that the limitation of this diagram is a population of 100 persons to an acre. Some towns have a much greater density of population than this, for instance, in Manhattan, New York, it approaches 1,200 persons per acre, but where it exceeds, say, 100, it can be assumed that the area in question is entirely built up on and the factor will be almost unity.

It is, of course, essential that the drainage area should be divided into smaller districts, the number of houses in each district be counted, and, allowing a certain number of inhabitants to each house, the population per acre is ascertained, and the diagram (Fig. 1) will give the coefficient of impermeability.

The following comparison of German and British standards will be useful:—

German classification of areas.	Equivalent British standard in population per acre.	Coefficient of impermeability
(a) Area densely built upon	75	0.80
(b) Area less densely built upon with larger yards	55	0.60
(c) Area having houses with larger gardens and yards	45	0.50
(d) Area openly built upon, detached villas, etc.	25–35	0.30–0.40
(e) Rural districts with gardens, meadows, etc.	15	0.20
(f) Parks, forests, etc.	5	0.10

Retardation.—In addition to the foregoing factors, which influence the manner in which storm water is discharged from any area, there is still another.

If the time required for the storm water to flow from the upper end of any sewerage system to any other given point is longer than the duration of the storm, then the water from the furthermost limits will reach the latter point when the water from the vicinity of that point has already been drained off, and thus the whole area, in such a case, will not be contributory simultaneously. In other words, the water from the remotest parts of the drainage area, owing to the distance it has to travel to the point in question, has been retarded from being discharged at the same time as the water from the parts near the lower point, hence the term "retardation." Mr. Baldwin Latham, one of the leading British engineers, stated that although rain fell in Manchester for 151 hours and 10 minutes, it took 1,008 hours for the water to flow off through the sewers, and this he attributed to an "extenuation of the flow."

To arrive at an appreciation of the influence of retardation, we may consider the subject in the following manner:

Let "L" denote the length of a sewer and "V" the mean velocity of the flow of water in the sewer, then if we consider a small quantity of storm water entering the upper end of the sewer, the time it will take to reach the given point or outlet will be $\frac{L}{V}$. If "D" denotes the duration of a storm, then the total time "T" from the commencement of the storm to the moment when the storm water will practically cease to flow through the sewer will be:—

$$T \text{ equals } D + \frac{L}{V}.$$

That is, the time for discharge, whether the water flows in an open water-course or in a close sewer, will be greater than the actual duration of the storm. But this fact does not warrant the sectional dimensions of the sewer being diminished, for such a reduction is possible only when the duration of the storm is less than the time required for the water to be discharged through the sewer, that is when "D" is smaller than $\frac{L}{V}$ or when "L" is greater than $V \times D$.

* Consulting Engineer, Regina.
† Civil Engineer, Regina.

With storms of great intensity and of small duration retardation will take place, even in short lengths of sewers, but when the storm continues for hours, retardation will have no influence, even if the sewers are of considerable length. It will depend upon the duration of the maximum precipitation assumed and on the velocity of flow in any particular sewer, whether or not retardation will take place.

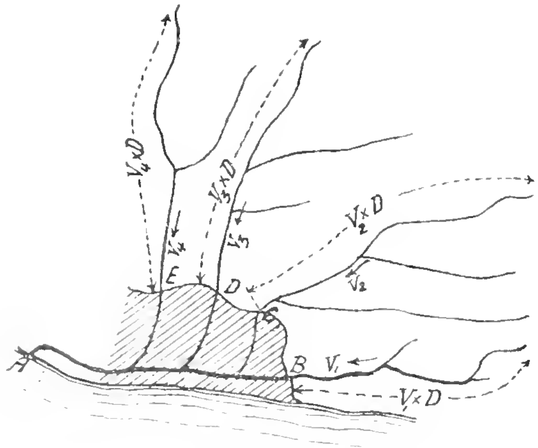


Fig. 2.

If the drainage area is within that part of a city which is built upon, then "V" will be determined solely by the inclination given to the sewer. The time required for the water from the roofs, yards and paved streets to drain into the sewers will be so short in comparison to the period which the storm water will take to reach the outlet, that is can be ignored. In the case of rural districts or openly built upon areas of a city, it will be necessary to allow a minute or so for the water to reach the sewers.

If an area such as is represented by Fig. 2 is considered, the value of V × D for the upper lengths of each sewer can be computed, and then the points B, C, D, E will indicate the limits of the area in which retardation will occur and must be taken into account.

In most cases the duration of a storm which will give rise to the maximum rate of flow will be not less than 20 minutes, or 1,200 seconds.

"V" is usually greater than 2.3 feet per second, therefore, in sewers shorter than 2,500 to 3,000 feet in length retardation may be considered as exceptional.

The question will now, doubtless, be asked, what will be the effect or influence of retardation on the discharge of storm water?

Such influence may be made clear in a simple manner if we consider a rectangular area E, F, G. H in Diagram F.

The line A-B represents the main sewer which drains the area bounded by the rectangle E, F, G, H. At the commencement of a storm of duration "D" the water from the vicinity of B will be the first to reach the outlet, and this is represented by the triangle H-C-B, which is shaded in Figs. 6 and 7. During the storm the adjoining area will be drained as indicated in Fig. 8. When the storm ceases, then the water from the vicinity of B will cease to flow, and this is indicated by the unshaded triangle H-N-G in Figs. 9 and 10. The length of the shaded part is equal to V × D. When the point C of the shaded part has reached the upper limit of the drainage district, then the extent of the figure representing the discharge will gradually diminish until the last portion of the storm water is drained away, as shown in Fig. 11.

Let "q" denote the quantity of storm water discharged per unity of drainage area.
"A" denote the extent of the drainage area.
"a" denote the contributory area,

then the ratio $\frac{q \times a}{q \times A} = \frac{a}{A}$ equals "R" the factor by which $q \times A$ has to be multiplied so as to obtain the actual quantity of storm water discharged. This factor is called the factor of retardation.

Example: Let "L" equal 12,000 feet; "V" equal 2.3 feet per second; "D" equal 1,200 seconds.

Then R equals $\frac{a}{A} = \frac{V \times D}{L} = \frac{1{,}200 \times 2.3}{12{,}000} = 0.23$ of the area.

By the foregoing discussion and diagrams it is manifest that, in addition to rainfall intensity, the configuration, extent, and shape of the drainage area, as well as the velocity of flow in the sewers, are the essential factors which may cause retardation.

Drainage Area, Configuration.—It is manifest that the permeability of a surface must be a question of degree, for even dense clay will absorb water if it is given time. If the drainage area is very flat and even rain water will naturally remain on the surface for a longer period, and will be gradually absorbed, evaporated or drained away. The time it takes to flow off the surface depends on the slope and general configuration. In a district which consists of hills and dales, the water will run off quickly. Configuration also constitutes an important element in the laying out of storm water sewers.

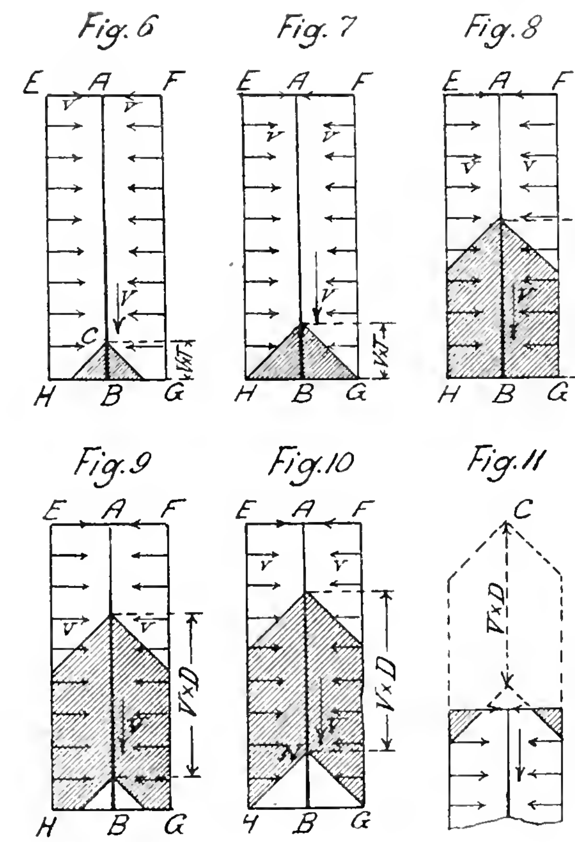


Diagram F.

Extent.—The extent of a drainage area, as far as retardation is concerned, is a matter of importance, so far as it is a function of its length. For it will be agreed that the time required for the water to concentrate at any given point will depend on the distance it has to travel and, according to statements already made, the intensity of a storm will vary inversely in proportion to the length of the sewers.

Shape.—The shape of a drainage area is another factor which has to be considered, for if the area is long and narrow, it will be observed that the period of concentration will be greater than if the area is compact.

Velocity of Flow in Sewers.—The factor of retardation is controlled by the velocity of flow in the sewers, inasmuch as the latter directly determines the time of concentration, that is $T = \frac{L}{V}$. If the sewers are laid with steep grades, a larger drainage area will be contributory, in a given time, than if the grades were made flatter. High velocities tend to eliminate retardation, whilst low velocities cause retardation to take place sooner.

Generally.—It is a matter of considerable importance that protection should be afforded the public against flooding, for apart from the disagreeableness of such an occurrence, it is also a menace to the health of a community. There is, however, a limit to which the engineer is justified in expending large sums of money in the construction of sewers of such dimensions as to be absolutely safe against flooding or gorging.

If the greatest rainfall intensity ever observed in any district is assumed as the basis for calculating the dimensions of sewers, it may be found that the sewers will be of such inordinate sizes that they will rarely be used to their full capacity and be so costly as to be financially impossible.

To adopt lower rainfall intensities will mean the facilitating of the execution of such works, but this may also incur some liability caused by occasional floods. The question, therefore, for the engineer to carefully consider is the disadvantages that may arise by the adoption of lower rainfall intensities as compared with the increased cost of larger sewers.

In Germany about 70 litres per second per hectare represents the lower limit, but this, according to observations made in Berlin, for instance, is exceeded about five times each year. To exceed 150 litres per second per hectare is recommended only in exceptional cases.

In districts such as Basel, where the annual rainfall (840 m.m.) is considerably greater than in Berlin (597 m.m.) a greater rainfall intensity is assumed, for instance, Burkli-Ziegler considered 125 to 200 litres per second per hectare as suitable for Switzerland.

Both Hawksley and Burkli-Ziegler's formulae were intended to include all circumstances which tended to diminish the discharge. Subsequent to their investigations, it was realized that the influence of the different conditions of impermeability of the surface deserved more attention and consequently other engineers introduced a separate co-efficient to cover that point. Following this slight development of the problem, however, German engineers have more fully developed the important features of the factor of retardation. Many capable American engineers have endeavored to construct a formula which will be generally applicable for computing the discharge of storm water, but they have met with very little success, because they tried to combine the heterogeneous factors affecting such discharge.

Mr. Lloyd Davies and Mr. Wallington Butt stated that the maximum discharge is attained when the duration of the storm equals the time of concentration. As the intensity of a storm varies inversely with its duration, in the case of sewers having great lengths the intensity will consequently be considerably reduced.

In many instances, however, it is not a storm of long duration and low intensity, but a storm of short duration and a great intensity, will cause the maximum rate of flow in sewers, even if only a fractional portion of the area is contributory. For example, in a district having an irregular shape, where the area near the outlet constitutes the major part, then during severe storms the water from that portion will concentrate quickly at the lowest point, whilst that from straggling and remote parts will require more time to reach the same place. It in such a case the intensity is derived from the time of concentration, then it will be too low.

It also often occurs that rainfalls of high intensity and short duration cannot be ignored, as they may happen when the sewers are already filled by the runoff of the preceding rainfall.

In an important case, it is highly desirable to ascertain which kind of rain will give rise to the maximum rate of flow.

A rainfall of high intensity will generally be assumed and the discharge ensuing is to be considered in its different stages. This can be effectively done only by constructing flow-areas as has been suggested by the late Prof. Frühling, of Dresden.

Such flow-areas can be drawn on squared paper, the horizontal lines—abscissae—will represent the time in minutes and the vertical lines—ordinates—will represent the volume of storm water in cubic feet.

The method suggested by the late Prof. Frühling will be explained in the next issue.

(To be continued).

INTERURBAN TROLLEY FREIGHT SERVICE AND RELATION TO HIGH COST OF LIVING.*

By Edward C. Spring,
Assistant to President, Lehigh Valley Transit Comany.

No agency in modern times has done more for the development of communities, the building up of municipalities and the revolutionizing of the social life among the masses of this country than the trolley systems of the United States. They have brought the farmer in close touch with the markets of the civilized world. They have brought the farmer's family in close touch with the educational advancement which this country offers, and to-day it seems to me that the interurban trolley lines of the country can do more to break down the middleman's profit and to place the product of the soil at the door of the consumer with greater dispatch and less variations in price than any other agency.

Recent legislative enactments in many of the States favorable to the handling of freight and express matter by the electric lines have caused the operators of such roads as are affected to establish a freight or express business. Hitherto the handling of trolley freight has received comparatively little attention in the East, considerably less in general than the attention given to it in the Middle Western States. But the roads of the Middle West have not fully demonstrated or satisfied themselves as to the best course to be pursued in taking care of this new branch of the service. The diversified conditions that exist among the various roads and the difficulty in harmonizing these various conditions present a situation which must be met. The growth of the freight and express business during the past four years has been wonderful. The frequency of service and the connecting of small towns between cities hitherto isolated from the outside world have been two of the greatest factors for the development of this branch of the service.

The number of advantages offered by the electric lines in the handling of commodities is fast becoming more apparent each day. The placing of the farmer in close touch

* Abstract of paper read before the City Club of Philadelphia January 18th, 1913.

with the markets of the world, through the medium of the electric lines, offers in itself one of the greatest inducements to the interurban lines running through a farming community. The establishing of freight stations and platforms in the various towns and cross-roads enables the handling of freight and express more carefully and with greater dispatch, and also makes a convenient place for the transfer of the merchandise. As the industrial and commercial needs press the interurban roads to keep pace with the demand for greater freight transportation, this need will be met in the same energetic and progressive manner as has characterized the past development of passenger transportation.

The great ease with which agricultural products can be brought into the large cities has enhanced farm values through the various territories served by the electric lines, together with the shipments of local produce into the cities, the counter-current of development of groceries and other store products to the various towns along the line takes place. That the various municipalities may be benefited from this new class of service, the farmer must be brought into close touch with the benefits of this service, as it concerns him.

Much has been told the farmer by the State Agricultural Institutes how to prepare the ground, till the soil and plant, to produce the best results, but very little has been told him how to find a market for his product after its development. It has been my interesting work in the Middle West, and is at present with the company that I represent, to bring the farmer's attention to the most important agency that has wrought a revolution in bringing the country into close proximity with the city and to familiarize him with the intermediate relations which exist between the transportation companies and the farmer. I am a firm believer that as the farmer goes, so goes the nation. To anyone who has studied the farming conditions in the Middle and Western States, this is most forcibly impressed. It is not a question to-day of the farmer taking his cue from Wall Street, but Wall Street being subservient to the will of the farmer.

The community in and about Philadelphia is splendidly served as far as the farmer is concerned by the up-to-date service of the transit companies, which have recently established a fast express service at freight rates between the various points and the city of Philadelphia. The company with which the writer is connected has established a brokerage department in connection with its express and freight service between Allentown and Philadelphia along the Lehigh Valley and through the North Penn region, whereby the farmer can secure a market for his commodity without going to the city or taking up his time. The company does not charge the farmer for this service. This is a great feature of the express service, and one which has never been handled by an Eastern trolley line before.

The time is past when the farmer does not put a valuation upon his own time and that of his team. To-day in the management of the farm, these two factors are entering in the maintenance account to a large extent. When the farmer can place his commodities upon the cars of the trolley lines, he can not only utilize his own time, but that of his team to greater advantage at home, rather than driving to market.

I have purposely tried to impress upon you the close relationship that exists between the farmers and the electric transportation companies in the great work and development of the farms and the products and the placing of the same within the reach of the masses at sane and rational prices. The farmer in the aggregate is not receiving for his product to-day any more than he did ten years ago, but the consumer in our large cities is paying from 50 to 100 per cent. more for the same goods, and it is certainly evident, even to the casual observer, that the middleman is the one who is reaping the major part of this advance, and to-day the one agency that is doing more to break down the middleman's profit is the freight and express service of the interurban lines.

The electric lines of the United States occupy no mean position in the commercial and mercantile interests of the country, and are in a position to play a very important part in the future development of the country. According to the last census, there are in the United States 1,279 operating companies, 40,088 miles of operated track, operating 89,601 cars. These companies have a total stock and bond issue, authorized, of $7,182,781,212, and outstanding, $4,682,106,217.

I firmly believe that the establishment of city markets at various sections of a large city, with tracks running directly to the same, so that the market garden products may be delivered directly to these markets, also various freight terminals to be established as near the centre of the metropolitan districts of the city as conditions may permit, would be one of great advantage to such city.

The city of Philadelphia, unfortunately, owing to the wide gauge of the city tracks, cannot allow direct communication without transfer from most of the outlying electric lines.

These matters should all have the attention and the endorsement of the engineers in laying out the future transportation plans for the city. The desire of the farmers to ship their goods over the electric lines in preference to steam roads is an evidence and proof of the benefits of this service.

The company, which the writer represents, is probably doing more to-day than any other electric railway company to develop this class of business, and transversing as it does the highly productive counties of Montgomery, Bucks and Lehigh, for a distance of fifty-eight miles to the north of Philadelphia, this company is in a position to serve the city to great advantage. So rapidly has the business of transporting farm products developed that this company has ordered several new cars to give increased service. The field of transporting farm products by the trolley lines, as far as the section in and around Philadelphia is concerned, has hardly been entered into as yet, and the large volume of business which will be developed by the trolley companies and the increased advantages which will revert to the city of Philadelphia cannot be estimated.

The recent advent of one of the largest old-line express companies on the Lehigh Valley Transit Company's line is but an added feature to the progressive and up-to-date methods that are being instituted for the benefit of the Philadelphia markets.

The key to the success of any interurban trolley service is its terminal facilities in the large cities. A system of trolley freight terminals must be established to better bring the producer and the consumer in close touch, eliminating all possible chances of the middleman. A fair adjustment of rates on the part of the city line with the interurban roads must be made, that the through rates for transportation between the farming districts and the city will be so attractive that the farmer will ship his product by means of the trolley rather than by any other. These are all factors which must be taken up in the city of Philadelphia in order to bring about the desired results. At the present time the city lines are receiving the same percentage of the through rate for a haul of five or six miles as the interurban lines are receiving for thirty or forty miles. It seems to me that these two factors, namely, terminal facilities and rates charged by the city lines, are most important and of vital interest to the city of Philadelphia in the development of the electric freight service.

A HIGHWAY DEPARTMENT ORGANIZATION FOR A LARGE CITY.*

By Wm. H. Connell.†

The most important and most neglected branch of the municipal governments to-day, is the division of highways. This is probably due to the fact that only within the past few years has the public taken an active interest in the condition of the streets. Wide avenues, good pavements and clean streets are not only appreciated but demanded by the public to-day, which accounts for the significant fact that every live municipality is struggling to develop a highway organization that will enable it to meet the demands of the public.

The time has arrived when municipalities must develop highway organizations commensurate with the present day requirements of this all-important branch of municipal government. It is needless to say that the development of up-to-date municipal highway organizations, like the good roads movement, is in its infancy, but the two go hand in hand and have come to stay, and if any governing body wishes to be popular with the public, it will be well for it to look to its highways. The highways represent the most conspicuous show case of the municipal government—thus the importance of paying particular attention to the goods placed there. It pays and pays well for business establishments to design attractive show cases, place their best goods in the window, and maintain a clean and attractive display; and so it would pay municipalities well to design attractive highways, lay good pavements, and maintain clean and attractive streets. It must be remembered, however, that this cannot be done by wishing. But unfortunately a half-hearted policy has been the one most in evidence in many municipalities to satisfy the popular demand for attractive highways and good pavements. The solution of the problem is an up-to-date municipal highway organization, made up of the right kind of personnel working as a unit.

No matter how large or how small the municipality may be, the underlying principles constituting the foundation of the highway organization are the same. If a lawyer or business man were going to build a house, he would employ an architect, tell him how much money he had to spend, give him an idea of the size of the house wanted, and leave the rest to him. He would also select an architect with experience in the design of the type of structure he wanted. The same procedure should be followed in organizing a municipal highway division, and it is a very simple one to follow. Select an engineer whose experience has been gained in highway organization work; tell him about how much money he will have to spend; give him an idea of the mileage and area of streets and the scope of the work coming under his jurisdiction; and he will build up a successful organization —provided he follows the same principles the architect must to design a substantial house, namely, select the materials best suited to support the structure. The highway organization, like the house, to be substantial must be composed of of men capable of upholding and controlling the respective divisions of the organization coming under their control. If this procedure is followed, the organization will be permanent and will stand, unless seriously interfered with, even in the absence of the engineer who built up the organization, member by member. When an organization is perfected, it is in the same category with the completed hou[illegible] requiring maintenance to hold its own. But if it is to be kept up-to-date, it will require changes and improvements commensurate with the demands of the time, and increased population—the house as well as the highway organization.

The outline of the underlying principles governing the procedure to be followed in forming a municipal highway organization makes it very evident that at most it is not a difficult task to start right, but right here municipalities only too often have failed. The lawyers and business men placed at the head of the public works departments have not followed the procedure they would in building a house or doing something else that would require a like amount of intelligence in the selection of the tools to work with. They have either attempted to build up the organization themselves, or have selected engineers whose principal qualifications have been that they were specialists in reinforced concrete, waterworks, sewer works, etc., or in short anything but highways. And what has been the consequence? These men spend three or four years or more groping in the dark, studying the rudiments of the requirements of a highway organization, and by the time they are just beginning to find themselves, and appreciate that highway engineering is a special branch of the engineering profession, the public has become impatient, and justly so.

This we all know has occurred only too often with well-intentioned administrations. Such control of the highway situation retards the advance of modern highway organization and engineering just as much as the old-time political administration of the highway bureau, and the reason is that the public expects something from the well-intentioned administration and doesn't get it, while in the latter instance they did not expect much and usually were not disappointed.

A proper start usually results in a good finish, but not without a hard fight, and even though the right engineer be selected to head a highway organization, his path is not strewn with roses. There is so much that is wrong and so little that is right in many of our municipal highway organizations, that the opportunity for constructive work is almost unlimited, aside from the efforts required even to keep abreast of the times with the construction work, and above water with the maintenance.

Assuming that a highway organization has reached the stage of development where its personnel is qualified to handle the work, the next and most important step toward efficiency and economy is to centralize the control of streets.

It may appear rather odd to some, but nevertheless it is a fact, that very few, if any, highway organizations control the streets coming under their jurisdiction. The control is usually divided up between the street railways, telephone, telegraph, electric light, gas, and other corporations. If when these companies tear up the streets they are permitted to make their own repairs, there results a confusion which takes away from the highway bureaus the direct control of street repairs. Such arrangements as are necessary should be made to place all repair work directly under the highway bureau. If the repair work is done by contract, the contract should be with the city. The highway bureau should have sole authority to repair or order repairs, of whatever nature, that are to be made. This would give the bureau a direct control over the contractors, and place the responsibility on the bureau for the condition of the streets and do away with the excuses we so often hear from city officials, that "The railway or telephone company is responsible for such and such repairs, and we are doing our best to push along the work." With this divided responsibility for the condition of the streets we can never expect to reach the highest point of efficiency in our highway organizations. The parkways

---

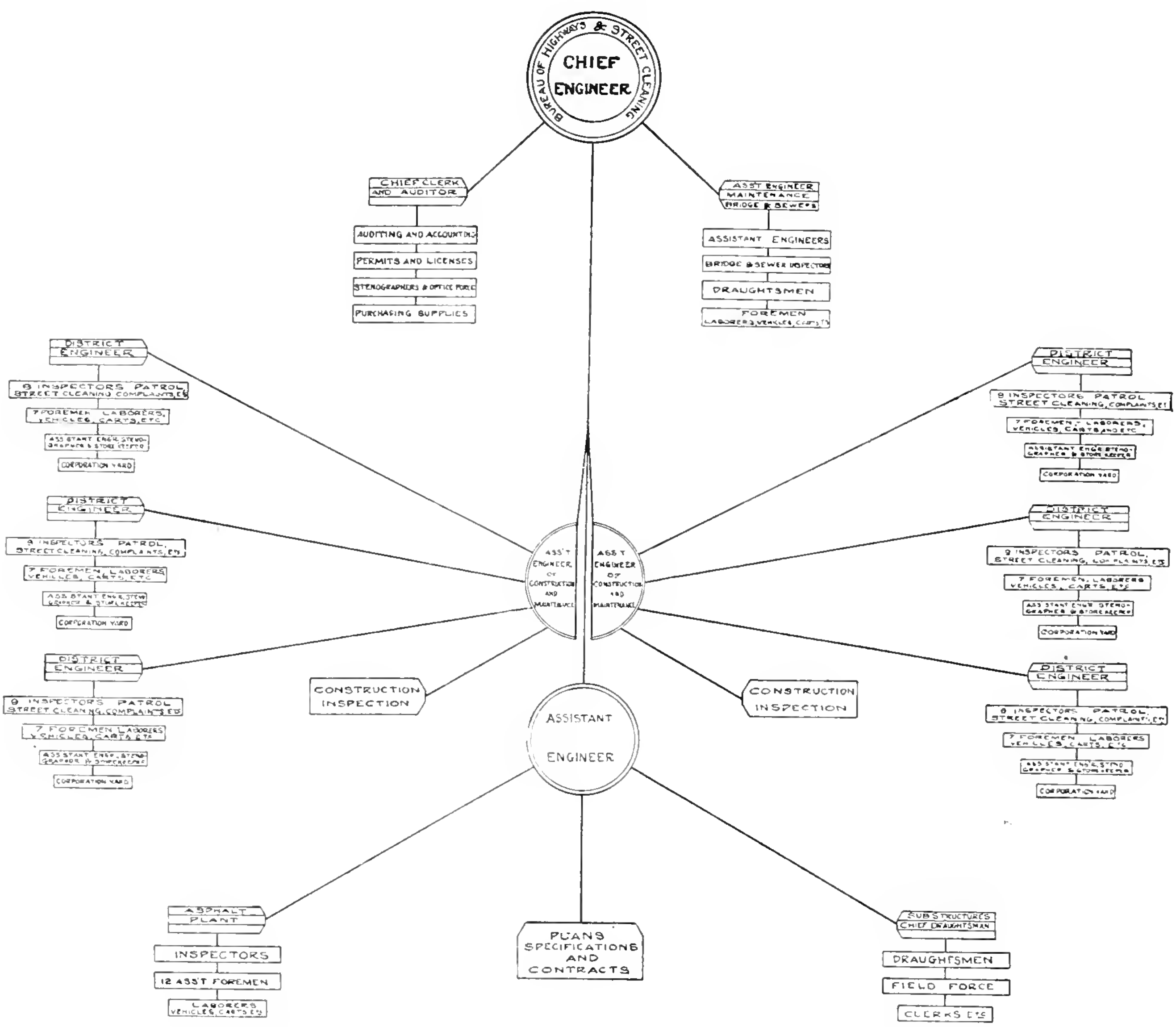
* From a paper read before ninth annual convention of Ameircan Road Builders' Association, held at Cincinnati December, 1912.

† Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

and main park driveways should also be under the control of the highway bureau as there should be but one system of highway construction and maintenance in the municipality.

The principle of centralization of control is the governing factor in a municipal highway organization, as it is also in any other organization of whatever nature. No business enterprise can compete with other business enterprises and be successful, unless the control of the organization is centralized and all the branches and subdivisions are co-operating and working as a unit for the success of the enterprise. This can be accomplished in a highway organization only of control, and such control cannot exist unless each individual in the organization is charged with his responsibility. If more attention were paid to the old saying, "Men will be led, but not driven," there would be less disorganization in municipal highway and other organizations.

Another very important step toward the control of street repairs is the establishing of municipal repair forces. The city should not be forced to depend upon contracts for work of this character and indeed, the only way to control completely wear and tear repairs as well as cuts is through municipal forces. Such repair forces naturally fall into four



ORGANIZATION CHART OF THE HIGHWAY DEPARTMENT FOR A LARGE CITY.

by first assuming such control of the streets that the responsibility for all conditions that may arise will be placed unqualifiedly with the highway bureau. Second, the subdivisions should be so organized that they will all be in close touch with the central office and working as a unit; there must be no overlapping of jurisdiction, and the policy emanating from the main office as to methods of carrying on the work, should permeate the whole organization. Each factor in the organization, from the common laborer up, should be schooled in a sense of his responsibility and know where it begins and ends. No man will do his best work unless he be instilled with a sense of his responsibility. The success of the organization at large depends upon co-operative efforts which can be brought about only through the centralization

divisions: Asphalt, stone block, wood block and brick, and macadam. In a few cities some success has been obtained with city gangs in repairing wood block and asphalt block streets but the big problem does not include either of these. Properly organized, a municipal asphalt plant is a step toward centralization of control over pavements, provided the area of asphalt pavements warrants a plant for repair work. No less important, however, are the repair gangs for the granite, brick and macadam pavements.

It is only within the last few years that the engineer has been finding out that city labor, properly handled, is far superior to that obtained through contracts. Ease in administration requires a municipal force for repair work as mobility cannot be obtained through any other than city

forces. In addition to this fact, it might be well to add that results obtained recently in various cities show a substantial saving by reason of the abandonment of contracts for repair work, and the substitution of city labor.

Too much emphasis cannot be placed upon the importance of centralizing the control over the pavements right in the highway bureau itself—and the larger the municipality, the more important it is that all street repairs be made by municipal forces. In any event, even though the organization is not equipped to handle the work, all contracts for repairs to cuts should be made directly with the city and not with the public service corporations. The most efficient and economic method of handling repairs, however, is by municipal forces.

After planning and working out a highway organization adequate for the requirements of the municipality, the first and most important step toward efficiency and economy in carrying out the work is the establishment of unit cost records, covering all classes of work carried on under the bureau. The basic principle of these records is simply to bring out by comparison the weak and strong points of the organization, which will act as a guide in planning and conducting the work in an efficient and economical manner. Comparisons of different subdivisions of one function of the organization may be made one with the other, or comparisons of like functions in different organizations, all of which tends to improve the methods of carrying on the work, impresses the men with their responsibility and at the same time arouses the sense of pride they should have in their work. Unit cost records are simply a modern system of records designed to raise the standard of efficiency and economy in conducting work. All maintenance work should be initiated through job orders issued from the main office, with the exception of emergency repairs, which work should be controlled through a job order issued by the superintendent or engineer in charge, a carbon copy of which should be transmitted to the main office. The foreman should be supplied with a force account and daily report sheets, through which labor hours, foreman's time, team time, and material used could be charged under their respective job order numbers and each day transmitted to the main office where the unit cost records would be compiled.

The accompanying chart illustrates a proposed organization of a bureau of highways which embraces construction and maintenance of highways, street cleaning, collection of garbage, maintenance of bridges and maintenance of sewers in a municipality, with a population of about 1,600,000 and 1,500 miles of streets and roads to care for, of which 1,000 miles are paved with first-class pavements, 300 miles with water bound and bituminous macadam and 200 miles of dirt road. It is assumed, of course, that all street repair work and bridge and sewer maintenance, as far as is practicable, will be done by municipal labor, and all original construction and repaving by contract.

The organization, it will be observed, is divided into five main divisions, which in turn are subdivided in accordance with the requirements of the functions of the respective divisions. A chief clerk is in charge of the clerical force, which embraces auditing and accounting, permits and license division, stenographers and clerks purchasing supplies, etc. The maintenance of bridges and sewers is under the direction of an assistant engineer, and is subdivided into two divisions, maintenance of bridges and maintenance of sewers. All minor repairs to bridges and sewers are made by municipal labor, more extensive repairs by contract. Sewer cleaning, of course, is done by municipal labor.

The supervision of all regulating and grading of streets, construction and maintenance of pavements and street cleaning is divided into two main divisions, each under the direction of an assistant engineer. Both of these divisions are subdivided into three districts, each under the direction of a district engineer. Each district has nine patrol inspectors, whose duty it is to report and measure all defects in pavements, plumbers' cuts, corporation cuts, and report encumbrances, answer complaints, etc., and supervise the street cleaning and collection of garbage, which have been assumed to be under contract in the organization under discussion. It is strongly recommended, however, that this work be performed by the municipality itself, as it is the only logical way to properly control it. It will also be observed that each district engineer has under his jurisdiction seven foremen, laborers, vehicles, carts, etc., assistant engineer, stenographer, storekeeper and corporation yard.

The number of patrol inspectors, assistant engineers, foremen, laborers, etc., may vary somewhat, depending upon the requirements of the respective districts, but the total number is approximately correct for the municipality at large.

Construction inspectors are assigned to each district as occasion requires by the assistant engineers of construction and maintenance. The other main division comprises the office force in charge of plans, specifications and contracts, the asphalt plant, and the division of subsurface structures, and is under the direction of an assistant engineer. The division of subsurface structures is a most important division, and the rules and regulations governing the placing of subsurface structures in the street, after a pavement has been laid, cannot be too strict. This is one of the most serious problems confronting the municipal engineer, and indications point to its not being under proper control in any municipality in this country. The only real solution of the problem would seem to be underground pipe galleries. The evil, however, can be minimized by exercising a more thorough control over the corporations by insisting on a strict compliance with rules and regulations designed to permit of as little disturbance as possible to pavements after being laid.

A testing laboratory has not been mentioned, as it is assumed that the municipality would have a laboratory equipped to handle the work of all the city departments.

The primary considerations in making up the accompanying chart were to illustrate a practical scheme for carry-on the work of an organization, such as referred to in this paper, by subdividing the responsibility for the work in such a manner that the chief engineer will not be swamped with detail, but at the same time will be in such close touch with all the work under his jurisdiction that he can intelligently direct and thoroughly control the operations of the bureau.

The organization under discussion has been used as an illustration in this paper, as it is one with which the writer is familiar, but is not presented as an ideal municipal highway organization—the object simply being to illustrate the essential features that must necessarily be considered in order to successfully control a municipal highway organization. The fundamental principles under discussion, however, would apply to any like organization; any deviations would simply be of minor detail.

A copy of the Queen's Engineering Works Magazine, published by W. H. Allen, Son & Company, of Bedford, England, has been received by The Canadian Engineer. This magazine is published primarily to keep their old pupils and apprentices in touch with this firm, and contains many articles of interest to them. We have been requested to call the attention of those interested through these columns.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

Design and Construction of Steam Turbines.—By H. M. Martin, London. 372 pages; cloth; 7½ x 11 in. Longmans, Green & Co. Price, $6.00 net.

Reviewed by R. W. Angus, B.A.Sc.*

This addition to a fairly long list of books on this very important subject is written especially for engineers who have had sufficient training in thermodynamics and mathematics to understand moderately difficult theory. As it contains a good deal of descriptive matter, however, and a large number of dimensioned drawings, it should prove helpful to the less skilled reader. The author states that the theory contained in the book is based on articles contributed by him to "Engineering" (London), the illustrations and descriptive matter being also largely from the same periodical.

The first chapter is brief, and is designed to give an idea of the action of a turbine, and to explain in a very elementary way the different types of wheels in use, these types being illustrated by water turbines. The chapter is too short to be of much help to anyone not having a pretty general knowledge of the subject, and the author might, with advantage, have elaborated his explanation somewhat.

The next chapter deals with the flow of steam through blades and nozzles, and proceeds at once to compute the velocity of steam from nozzles and the work done during various forms of expansion. The Mollier diagram is introduced and used as far as possible in the calculations, the author assuming that the reader understands the theory of the diagram, although this is explained in a later chapter. This important diagram deserves a place in any such treatise, and the value of the book is enhanced by explaining the use of Mollier's diagram and giving a copy of it for use.

Chapter III. describes a number of experiments made on nozzles and blades, showing somewhat the effect of the shape of the nozzle. The book then deals in the following chapter with the impulse turbine, illustrating with the turbine of Dr. Laval. The velocity triangles are drawn, and a method explained of finding the "indicated work done" on the turbine shaft by which the author means the turbine output plus the mechanical friction. This is then used to determine the efficiency of the wheel itself, and the whole is illustrated by a numerical example.

A table is given of a series of tests on impulse wheels to determine the wheel efficiency. The chapter concludes with a discussion on shock and proper velocities in the bucket.

In Chapter V. there is a discussion of the term efficiency ratio, or the ratio of the theoretical to the actual steam consumption, and the reasons for adopting multi-stage expansion, together with the resulting losses. The method of proportioning the turbine is merely suggested. In the following chapter a very interesting set of curves is given, which enable the designer to infer the results which he will obtain on a given turbine from the results of tests made on a similar turbine under different conditions, these curves enabling one to reduce any set of observations to corresponding results under a different set of conditions.

The actual design of the impulse turbine is dealt with by the author in two steps, the first dealing with the general proportioning of the parts and the determination of the probable steam consumption, etc., while the second step deals with the dimensions of the blading. The method of procedure is altogether too complicated to be discussed in this review. In general it may be stated that the limitations of the work have forced the author to assume formulas without proof, to which, however, fair exception could scarcely be taken. A chapter has been devoted to velocity compounded impulse wheels.

A number of chapters have next been devoted to reaction turbines and their design, which have been treated with a fair degree of completeness, and some difficult problems in this part of the subject are dealt with. Numerical examples have been given in certain places, and there are many useful tables and practical coefficients.

Following a chapter on the radial flow turbine, the author has given a considerable amount of theory and explanation of the thermodynamic principles involved in the turbine design, dealing also with the Mollier diagram, which has been used in earlier parts of the work.

Having treated the design from the thermodynamic standpoint, the author devotes a number of chapters to the mechanical details, there being a chapter on each of the following: Balancing, Dummy and Gland Packings, High-speed Bearings, the Strength of Rotating Discs, Geared Turbines, and the Condenser, this part occupying a fair proportion of the whole work. One could not expect the most complete treatment of these matters in a book of the size under discussion, and yet the treatment is fairly complete. For example, in the part dealing with dummy and gland packings various designs have been sketched and the method of calculating the probable leakage discussed in detail. Some dimensioned drawings have also been given.

The latter third of the book is almost entirely descriptive, and gives details of all the principal turbines, such as the A. E. G., Curtis, Rateau, Zoelly, Parsons, etc., most of the descriptions being accompanied by detail drawings

* Professor of Mechanical Engineering, University of Toronto.

with many dimensions, thus making them of considerable value as guides to the designer.

The book, on the whole, is well gotten up, its make-up being much better than is found in general in engineering books, but it is rather unfortunate that it has not been made into a more portable form. The large pages, heavy paper, well-spaced lines and good margins are attractive, but tend to make a book rather heavy and unwieldy, as in the present case.

The engineer who is well versed in his theory should find the book a real addition to the literature on this subject; other readers will have to confine their attention largely to the descriptive parts.

American Civil Engineers' Pocket Book. Published by John Wiley and Sons, New York. Canadian agents, Renouf Publishing Company, Montreal. Second edition, enlarged. Morocco, 1,483 pages, 500 tables, 1,200 cuts, 16 mo. Price, $5 net.

This pocket book, which has now appeared in the second edition, and of which Mr. Mansfield Merriman is editor-in-chief, has been very well received by the engineering profession.

Two new sections have been added to this second edition: Section 14, setting forth those fundamental principles and facts of Steam and Electrical Engineering, which are of especial importance to civil engineers, and Section 15, giving the most recent practice in the construction and maintenance of highways and streets. Eight new pages have been added to the chapter on Earthwork Computations. Section 3, which formerly treated of roads and railroads, has been revised, and is now entirely devoted to Steam and Electric Railroads, seven new pages being added. Many other changes throughout the book are noted, to correct ambiguities, supply deficiencies, and bring the subjects up-to-date.

The index has been revised and entirely reset, and the preface states that all known errors, typographic and otherwise, have been corrected, and that alterations and corrections have been on more than one-fourth of the pages of the first edition. Necessarily, in the first edition, this book, which is the compilation of so many different authors, contained a number of errors. A list of these errors has been prepared, and a copy will be sent to any purchaser of the first edition who forwards his address for that purpose.

This issue contains 23 articles, 43 tables and 18 cuts more than the former edition. The volume in its enlarged form will certainly be most useful to the members of the profession and everyone who is at all interested in engineering should possess a copy.

A Manual of Cement Testing. By Richards and North. Published by D. Van Nostrand Company, New York. Cloth, 137 pages. Price, $1.50 net.

Reviewed by P. Gillespie, B.A.Sc.*

This little volume is intended for the guidance of analysts and inspecting engineers, and gives in small compass, the methods in general use of making physical and chemical examinations of Portland and other cements. No attempt to elaborate any special theory or to leave the beaten path has been made. An examination of the text gives one the impression that precision of statement and literary accuracy have not received the attention that they should receive in the preparation of a text book. Clay for example, is defined as a "more or less plastic substance composed chiefly of aluminium silicate formed by the decomposition of minerals"; limestone is said to be "a substance formed where clay has been deposited with a calcareous matter." Elsewhere we are told that "samples should be taken more often," and that "tests often do not check closer than 10 per cent." On page 41, one observes that "compression tests are not used as standard tests for the reception of a cement," and that "the form and size of the specimen most generally used are two inch cubes. . . ."

Within the covers of the little book, notwithstanding, is found much information on the appliances for and methods of cement examination. The appendix consists of a reprint of the standard specifications for Portland cement of the American Society for Testing Materials, 1909, and the methods of analysis of raw materials, cements, etc., suggested by the Society for Chemical Industry. The book, as a handy and compact guide to routine work, possesses some value.

*Associate Professor of Applied Mechanics, University of Toronto.

Manufacture of Iron and Steel. By H. R. Pearson, M. I. Mech. E., Kiangnan Arsenal, Shanghai, China. Published by E. & F. N. Spon, Limited, 57 Haymarket, London. Cloth; size, 6 x 9 in.; 104 pages; 21 illustrations. Price, $1.15.

This book seems to have for its object the giving of an outline of the principal operations connected with the manufacture of iron and steel. It is put in an interesting way for all, and is designated a hand-book for engineering students, merchants and users of iron and steel. This about correctly infers what one would expect to find in the book. It is not highly technical, but where technical expressions are used and necessary, they are often not explained till several pages further on in this book. For an untechnical man to properly read and understand the book it ought to be read through twice, the first time to obtain a general idea of contents, and then more carefully. It contains thirteen comparatively short chapters, with numerous little cuts and tables, as follows:—

This book ought to be of interest to all who, in a general way, are interested in the manufacture of iron and steel, and of value to students or others starting work in steel plants and desiring to quickly understand the practical work going on around them.

The New Building Estimator. By William Arthur. Published by the David Williams Company, 231-241 West 39th Street, New York. Flexible leather. Size, 4½ x 7 inches, 712 pages. Price, $3 net.

This book on estimating, first published in 1904, has now reached the eleventh edition. It is, without question, the best book of its kind to be obtained to-day covering the necessary data for the calculation of the cost of building construction. The subject matter is taken up both in detail and approximately. The value of this double arrangement lies in its giving the appraiser or estimator—who has to give quick and approximate figures—the information desired, while the detail section provides figures covering quan-

tity of material and the labor required, in carefully checked and prepared form.

In this present edition, all prices have been corrected, and about 250 pages of new matter covering reinforced concrete, measurement of building work, comparative costs, sprinkler systems, valuations, railroad figures, grain elevators, square foot costs, cost of wood trusses, equipment of buildings, apartment houses, etc. The style of binding has been much improved by the use of gilt-edged flexible leather in place of the previous stained edges and cloth covers.

In every way this book on estimating can be recommended both to the engineer and the architect. Certainly no engineer should be without a copy for ready reference.

Book of Standards. Published by the National Tube Company, Pittsburg, Pa.; 1913 edition. Pages. 559. Size, 4 x 6½ ins. Price, $2.

The 1913 edition of the Book of Standards has just been received from the press. The present edition, which is the first since the 1902 edition, is much larger and more complete than the older one. It is printed on Canterbury Bible paper, the book, including the binding being not quite five-eighths of an inch thick and will fit the pocket readily.

The information incorporated has made it strictly a pipe handbook, and as such, it is believed, will find an immense use with the trade. The index of the book will be found to be very complete, all headings being thoroughly cross indexed. There are approximately 4,000 references found in the index. Several pages are devoted to a descriptive article covering the main process of manufacturing both welded and seamless tubes, also giving information in regard to the threading, durability and physical properties, etc., of both "National" pipe and Shelby seamless steel tubes. There are a number of pages which give weights, dimensions, threads per inch, test pressure, sections of joints, specifications, ets., of the various kinds of pipe and tubing made.

An article on Protective Coating, Matheson Joint Pipe, and Converse Joint Pipe contains desirable information on these subjects. Tubular electric line poles receive considerable attention, the information given will help an engineer in understanding more about tubular poles which are being used by many of the larger cities as a medium for better service, better appearance, etc. Various types of joints are described and illustrated. Full tabular information is given for poles from 22 to 40 feet, showing lengths of sections, size of butt, weight, thickness, greatest load pole will carry, etc. Several pages describe, illustrate and contain tables in regard to lapweld and seamless tubes, upset and expanded, wrought pipe bends, butted and strapped joints, bump joints, valves and fittings, including various kinds of nipples and flanges, band railings and ladders, working barrels, cylinders, Shelby seamless specialties, Shelby seamless cold drawn trolley poles, tables of various physical properties of Shelby seamless steel tubes, physical properties of carbonic acid gas, Briggs' Standard, holding power of boiler tubes, thermal expansion of iron and steel tubes.

Considerable prominence is given to articles on strength of tubes and cylinders under internal fluid pressure and collapsing pressures. Both of these papers are very complete and have been extracted from papers by Prof. R. T. Stewart, Dean of Mech. Engr. Dept., University of Pittsburg, and read by him before the A.S.M.E. Several of the formulae are compared and results of actual tests are given. Tables are given which show the probable collapsing and bursting strengths of standard tubes. These articles and tables will prove of immense benefit to the mechanical engineer, especially in the connection with boiler engineering problems. An article covering pipe used as columns is given, tables are supplied showing the use of standard, extra strong, and double extra strong pipe based on the New York Building Code as well as the Chicago Building Ordinances.

Considerable attention is given to the mechanical properties of solid and tubular beams, of usual and unusual shapes. As tubing is finding considerable usage in the mechanical field, notably in automobile construction, this data is particularly useful. This article is accompanied by tables giving the mechanical properties of solid and tubular beams of uniform cross section, various conditions of loading are illustrated and formulas are shown to secure their physical properties values. Unusual shapes are illustrated and formulae given to secure their properties as beams or columns.

An article on safety factors and safe working stresses is given which shows through what ranges values should be used for safe operation. Chapters are supplied giving information in regard to water, gas, steam and air. It has not been the intention to go very deeply into these various subjects, only in so far as they concern tubular products. Perhaps the scope of these articles is best shown by giving a list of some of the headings, information in regard to which is given in detail:

Water.—Properties, Boiler Incrustation and Corrosion, Flow in Pipes, Measurement of Flowing Water, Water Power, Tables.

Gas.—Physical Properties of Cases, Flow of Gas in Pipes at both High and Low Pressure.

Steam.—Properties, Superheated Steam, Flow of Steam, Loss of Heat from Steam Pipes.

Air.—Properties, Expansion, Compression, Flow of Air.

A large collection of tables in conjunction with explanatory articles is given; an idea of the extent of which can be secured from the following list:—Fifth roots and fifth power; decimals of a foot for each 1-64 of an inch; decimals of an inch for each 1-64; wire and sheet metal gauges in approximate decimals of an inch.

Proportions of screw threads, nuts and bolt heads, illustrated explanatory article accompanied by tables showing dimensions of screw threads, nuts and bolts. Several pages are devoted to area and weight factors for tubes and pipes by means of which it is readily possible to figure tne area and weight of various kinds of tubing. A special table is shown by means of which it is possible to find directly the weights of nearly all sizes and thickness of steel tubing up to 36 inches in diameter. By means of factors weights of various other metallic tubing can be found. A table showing properties of tubes and round bars is given with an explanatory article. This table gives various physical properties, including circumference, area, weight, surface in square feet, volume, moment of inertia, radius of gyration, etc., for tubes and round bars up to and including 36 inches. This data is given in increments of .01 inches up to 16 inches and increases from there by ⅛ inch increments to 36 inches.

The metric system is included with conversion methods for most of the more commonly used measures, including temperatures. A glossary of terms used in the pipe and fittings trade will be found in the back of the book, and in many instances the meanings of many of the more or less well-known words used in this trade are defined.

Practical Mathematics for the Engineer and Electrician.—By Elmer E. Burns and J. G. Branch, B.S., M.E., Member of the Board of Engineers for the city of St. Louis, Member of the American Society of Mechanical Engineers. 8 x 5½ in.; cloth; 143 pages. Price, $1.00. The J. G. Branch Publishing Co., Chicago.

The authors assume that the reader knows little of mathematics, and the book is chiefly intended for the operating engineer and electrician. Those engineers and electricians who have never had the advantage of a college education will not find it written above their heads. It is also of value to those who have had a mathematical training on account of the practical way in which the subjects are treated. Apparently, it has been the aim of the authors to write it in simple, elementary and clear language, and to confine it to subjects of especial value to all practical workmen. The subjects treated cover a wide scope, but no subject treated requires knowledge of any preceding subject or any previous knowledge of mathematics. A person fully understanding all the subjects treated will pretty well have all the mathematics that is required to make him a first-class operating engineer or electrical worker. Practical questions with answers worked out are given. There is no list of contents to the book, merely an alphabetical index of the subjects treated.

PUBLICATIONS RECEIVED.

Bureau of Mines.—Twenty-first annual report for the year 1912. Printed by the Legislative Assembly of Ontario. 300 pages; five sheet maps accompanying the report; 17 sketch maps and plans; 130 illustrations. Contents: Statistical Review; Mining Accidents; Gold Fields of Lake-of-the-Woods, Manitou and Dryden; Porcupine Gold Area; Water Powers in the Porcupine Gold Area; Swastika Gold Area; Cripple Creek Gold Area; West Shining Tree Gold Area; Notes on McArthur Township; Geology of the Detroit River.

Barge Canal Bulletin.—January, 1913. Published by the Department of the State Engineer of State of New York. 40 pages. Contents: Progress of Contract Work; Progress of Plans being Prepared; Plans before Canal Board; Contracts Advertised; Bids Opened; Award of Contracts; Annual Report of State Engineer and Surveyor, first part.

Report of the Department of Trade and Commerce. For the year ending March 31st, 1912. Contains miscellaneous information on bounties, lumber, and staple products, revenue and expenditure of Department of Trade and Commerce, statistical record of the progress of Canada, tonnage table, etc. Department of Trade and Commerce, Ottawa.

Application for the Revision of the Toronto Building By-law.—A memorial presented to the Mayor, Board of Control, and City Architect of Toronto by a general committee of citizens representing various technical and business organizations of the city of Toronto. C. R. Young, 318 Continental Life Building, Toronto.

Bulletin of the Imperial Institute.—A Quarterly Record of Progress in Tropical Agriculture and Industries and the Commercial Utilization of the Natural Resources of the Colonies and India. Edited by the Director and prepared by the Scientific and Technical Staff of the Imperial Institute and by other contributors.

Engineering Problems Connected with Biological Sewage Disposal.—By T. Aird Murray. Part of a Symposium on Biological Sewage Disposal, Canadian Public Health Association, Annual Meeting, November 21st to 23rd, 1911. The Canadian Engineer, 62 Church Street, Toronto.

Roofs and Their Coverings. By Clough Williams-Ellis. Being the paper on Welsh slates. Re-printed by permission from "The Architect and Contract Reporter." Published by Spottiswoode and Co., Ltd., London, Colchester and Eton. Price, six cents.

Public Service Commission. Report of the Commissioners, Vol. 1, 1912. Comprises report on government dredging, report on the Department of Public Printing of Stationery, and special report on Temiskaming dam contract, Sorel shipyard and dismissal of R. E. Cook.

Weekly Report, Department of Trade and Commerce, Ottawa.—Bulletin No. 473, February 17th, 1913. Pages 183 to 205. Contents: Australia, Trinidad, Great Britain, Panama Canal, Canadian Produce Prices in England, British Agricultural Produce Imports, Grain Statistics, Trade Inquiries.

Methods of To-day on (1) Swimming Bath Water Purification, (2) "Overground" Conveniences, (3) "Vacuum" Exhausters, (4) Dry Closets, (5) Fly-proof Privies.—By James S. Dunn, Sanitary Department, Town Hall, Kimberley, S.A.

Water Supply of San Francisco. Report by H. M. Chittenden. A well illustrated cloth-bound book, 11½ x 9 in.; 44 pages. Secretary, Department of the Interior, Washington, D.C. This is a very beautifully gotten up report.

Hydro-Electric Power Commission. Third and Fourth Annual Report of the Province of Ontario for the year ended October 31st, 1911. The Hydro-Electric Power Commission of Ontario, Continental Life Building, Toronto.

Coal Mine Accidents in the United States. Monthly statement, January to August, 1912, and Statistics for 1910-11. Compiled by Fredk. W. Horton. Bureau of Mines, Department of the Interior, Washington, D.C.

Influence of Icebergs on Land on the Temperature of the Sea. By H. T. Barnes, B.Sc. Being supplement of the 45th Annual Report of the Department of Marine and Fisheries for the year 1911-12, Ottawa.

Cement Process of Excluding Water from Wells, as practised in California.—By Ralph Arnold and V. R. Garfias. Bureau of Mines, Department of the Interior, Technical Paper No. 32, Washington, D.C.

Engineering Experiment Station.—Bulletin No. 29, the Iowa State College of Agriculture and Mechanic Arts, on Cost of Producing Power in Iowa with Iowa Coals. By H. W. Wagner, Ames, Iowa.

Practical Kinks, Recipes and Tables. Collected by Joseph G. Branch. Published by the Joseph G. Branch Publishing Co., 608 Dearborn St., Chicago, Ill. Cloth; 5½ x 7½ in.; 143 pages. Price, $1.

Railway Statistics of the Dominion of Canada for the year ending June 30th, 1912. (From sworn returns furnished by the several railroad companies.) Department of Railways and Canals, Ottawa.

Questions With Answers on Pumps and Pumping Machinery. By W. H. Wakeman. Published by the Joseph G. Branch Publishing Co., Chicago, Ill. Cloth; 5½ x 7½ in.; 190 pages. Price, $1.50.

Alternating Currents Simplified. By E. E. Burns Published by The Joseph G. Branch Publishing Co., 608 South Dearborn St., Chicago, Ill. Cloth; 5½ x 7 in.; 199 pages. Price, $1.50.

Treatise on Scientific Methods of Concrete Construction, Using Lock Steel Form.—By the Hotchkiss Lock Metal Form Company. Sixteen pages, with an attached sheet of about twenty cuts.

The Resources of Tennessee.—Magazine devoted to the description, conservation and development of the resources of Tennessee. Published by the State Geological Survey, Nashville, Tenn.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other Metals in Canada During the Year 1911. By C. T. Cartwright, B.Sc. Mines Branch, Department of Mines, Ottawa.

Obligations of the United States as to Panama Canal Toll.—By Hon. E. Root, of New York, in the Senate of the United States. Address The Congressional Record, Washington, D.C.

Proceedings of Ontario Association of Architects.—Being transactions of the Special General Meeting and twenty-third Annual Convention. 96 King Street West, Toronto.

Facts About Treating Railroad Ties.—By W. F. Goltra. Twenty-four pages on the Essentials for Effective Work in Timber Treating. W. F. Goltra Tie Company, Cleveland, Ohio.

Report of the Minister of Public Works for the Province of Manitoba, for the year ending December 31st, 1911. Department of Public Works, Parliament Buildings, Winnipeg, Man.

Index to the Weekly Report.—Published by the Department of Trade and Commerce, Ottawa, for the year ending December 31st, 1912. Weekly reports number 414 to 466.

Report of the Minister of Public Works for the Province of Ontario, for the year ending October 31st, 1911. Department of Public Works, Parliament Buildings, Toronto, Ont.

The Iowa Engineer.—Published by Students of Engineering, Iowa State College; $1.00 per year. Published monthly. Forty pages. Iowa State College, Ames, Iowa.

Report of the Sixth Annual Convention of the Western Irrigation Society, held at Kelowna, B.C., August, 1912. Forestry Branch, Department of the Interior, Ottawa.

Annual Report of the Board of Regents of the Smithsonian Institute, for the year ending June 30th, 1912. The Secretary, Smithsonian Institute, Washington, D.C.

Report of the Director of Forestry, for the Year 1912. Being Part 6, Annual Report, Department of the Interior. Issued by the Department of the Interior, Ottawa.

Preliminary Review and Estimate of the Mineral Productions of British Columbia, for the year 1912. Bureau of Mines, Parliament Buildings, Victoria, B.C.

Ice Cold Storage (on the Farm).—Bulletin No. 207. The Ontario Department of Agriculture, Parliament Buildings, Toronto. Fifty pages, with illustrations.

Castings.—Published monthly. A reference for buyers of foundry equipment and supplies. The Gardner Printing Co., Caxton Building, Cleveland, Ohio.

Journal of the American Peat Society.—Devoted to the development of American peat resources. Secretary, Julius Bordollo, Kingsbridge, New York City.

Report with Reference to Civic Administration and City Development, of the City of Prince Albert, Sask.—By E. A. James, B.A.Sc., and T. Aird Murray.

Telegraph Statistics, Dominion of Canada.—For the year ending June 30th, 1912. A. W. Campbell, Department of Railways and Canals, Ottawa.

Queen's Engineering Works Magazine.—Published by W. H. Allen, Son & Co., Limited, at the Queen's Engineering Works, Bedford, England.

Commercial Review Showing the Export Trade from Port of Montreal of Canadian Products in 1912.—The Gazette, Montreal, Canada.

Annual Report of the Directory of Forestry, for the year 1912. 270 pages. Department of the Interior, Parliament Buildings, Ottawa.

Training with Mine-Rescue Breathing Apparatus. By J. W. Paul. Bureau of Mines, Department of the Interior, Washington, D.C.

Chemical Properties of Western Larch.—By W. A. Ross, Department of Agriculture, Forest Service, Washington, D.C.

Board of Governors' Report of the University of Toronto, for the year ending June, 1912. Parliament Buildings, Toronto.

Mine Fires and How to Fight Them. By James W. Paul. Bureau of Mines, Department of the Interior, Washington, D.C.

Accidents from Falls of Roof and Coal. By G. S. Rice. Bureau of Mines, Department of the Interior, Washington, D.C.

Annual Report of the City Engineer of Port Arthur for the year 1912. Twenty pages. L. M. Jones, City Engineer.

Estimates for the Fiscal Year ending March 31st, 1913. Department of Finance, Parliament Buildings, Ottawa.

Chemical Properties of Western Hemlock.—Department of Agriculture, Forest Service, Washington, D.C.

Bulletin No. 62, of the University of Illinois, on the Electron Theory of Magnetism, Urbana, Illinois.

Mine Rescue Work in Canada.—By W. Dick, M.Sc., Commission of Conservation, Ottawa.

CATALOGUES RECEIVED.

D. VanNostrand Company, 23 Murray Street, New York, forward the following four catalogues and books: Catalogue of scientific books, recently issued and in preparation; catalogue list of books on Producer Gas and Gas, Gasoline and Oil Engines; catalogue of a list of books on Scientific Management, Efficiency and Allied Subjects; catalogue of scientific books published between December, 1909, and October, 1911.

Induction Motors.—Engineering Works of Canada, Limited, New Birks Building, Montreal, P.Q., operating under the patents of "Société Alsacienne Des Constructions Mécaniques," forward Catalogue No. 1, of 15 pages, on two and three-phase induction motors.

Dynamos.—From 200 to 15,000 horse-power, under construction in the shops of Belfort, by the Société Alsacienne de Constructions Mécaniques. Representatives in Canada, Engineering Works of Canada, Limited, New Birks Building, Montreal.

Switchboard Indicating Instruments. — The Northern Electric and Manufacturing Company, Montreal and Toronto, forward a catalogue announcement re Weston Alternating Current Switchboard Instruments. Write for Catalogue 16.

Catalogue of central stations installed by the Société Alsacienne de Constructions Mécaniques, Belfort, for mines and metallurgical plants. Canadian Rrepresentatives, Engineering Works of Canada, Limited, New Birks Building, Montreal.

Catalogue of book.—Title, Internal Combustion Engine, a handbook for designers and builders of gas and oil engines. By Hugo Güldner. 700 pages; 728 illustrations. D. VanNostrand Company, publishers, New York.

"Bitumastic" Enamel.—Wailes, Dove & Co., Limited, 5 St. Nicholas' Buildings, Newcastle-on-Tyne, agents, Montreal, Toronto and Vancouver, forward an 18-page little catalogue.

Portmadoc Slates.—Festiniog Slate Quarries Association, Portmadoc, North Wales, forward a 15-page catalogue and pamphlet on slates.

Lentz Engine.—Catalogue from the Erie City Iron Works, Erie, Pa. A Poppet valve engine under patent.

Blacksmithing and Drop-forging.—Tait, Jones & Co., Pittsburg, Pa., forward a 16-page catalogue.

COAST TO COAST.

Regina, Sask.—The Emerson-Brantarghain Implement Company, of Minneapolis, who are represented here by Tudhope-Anderson Co., recently shipped forty-five car loads of tractors here. This is claimed to be a record for the shipment of a single commodity, as the value may be seen from the fact that the freightage cost $7,145.

Ottawa, Ont.—The Canada Cement Company, the Canadian merger, threatens that the fullest advantage of conditions will be taken to obtain the highest prices possible for cement during periods of restricted supply, so that later it will be able to accumulate reserve to meet the importations from the United States at slaughter prices if the government re-enact the duty remission of fifty per cent. enforced from July 1st to October 31st, last year.

Winnipeg, Man.—The Grain Growers' Grain Company have purchased timber limits near Fort George, British Columbia, comprising about 300,000,000 feet of lumber, at a price of about $1.50 per 1,000 feet. It is said to be the intention of the Grain Growers to hold this as a reserve supply with the idea of establishing lumber yards at different points in the province for the purpose of supplying farmers and settlers with lumber at reasonable prices.

Ottawa, Ont.—Sustained growth and stability in Canadian trade are indicated by the figures recently published. The customs returns approximated $106,000,000, against $83,906,706 during 1911. Adding to this excise duties for the year amounting to about $31,000,000, the grand total is $137,000,000. The statistics for the year show that the total trade of Canada with other countries from January 1 to December 31, 1912, amounted approximately to a billion dollars, the imports being $650,000,000 and the exports $350,000,000. The total trade during the previous twelve months amounted to $828,614,120, the imports being $524,850,792 and the exports $303,763,328.

Toronto, Ont.—The new provincial boiler regulations have received their final approval, so that after July 1st every boiler manufactured in Ontario, apart from railway and steamer boilers, which are covered by separate legislation, must be made along standard lines and stand a thorough inspection, not only on completion, but during construction.

Ottawa, Ont.—Jas. Stewart & Company, one of the oldest contracting firms in the country, has been incorporated under the same name with a total capitalization of $3,750,000. It was formed in Ottawa in 1845 by Jas. Stewart, a native of Aberdeenshire, Scotland, and in 1865 moved its headquarters to St. Louis. It has district offices in Montreal, Chicago, Pittsburg, Salt Lake City and New Orleans. The new company's principal offices will be in New York, where they have $20,000,000 worth of business booked at present.

Before the conference committee of the Board of Trade of the city of Toronto last Thursday Mr. Lionel H. Clarke and Mr. E. A. James, chairman of and consulting engineer, respectively, to the York County Board of Highway Commissioners, presented some interesting phases of the work the commission has already done and is still doing. Mr. Clarke treated the subject of good roads from a general viewpoint, while Mr. James went more particularly into details, and outlined what had been accomplished, and spoke of some of the plans for the future. Following the address the meeting was thrown open, and Messrs. Gundy, Hewitt, Ellis and several others took part. Before the meeting adjourned a resolution was moved and carried unanimously, as a result of which the Board of Trade will continue its efforts to have legislation brought about which will result in the continuance of the good work already begun.

The old-established firm of Hyde & Webster builders' and foundry supplies, of Montreal, which firm has gone out of existence, have acquired the still older established business of Messrs. F. Hyde & Company, 31 Wellington Street, Montreal, and under the name of Webster & Sons propose to continue same business in all its branches.

PERSONAL.

MR. A. W. ROGER WILKY, C.E., for the past eight years on the engineering staff of the Island branch of the Canadian Pacific Railway, has been appointed engineer-in-charge of all construction work of the Department of Marine and Fisheries for the province of British Columbia.

MR. MORRIS L. COOKE, director, Department of Public Works, Philadelphia, Pa., on February 18th, delivered a lecture on "Scientific Management as Applied to Highway Engineering," before the graduate students in Highway Engineering at Columbia University.

MR. VIRGIL G. BOGUE, M.Am.Soc.C.E., former chief engineer of the Western Pacific Railway, has recently been engaged in an economic study of line improvement and double-tracking of the Canadian Pacific Railway through the Selkirk and Rocky Mountains in British Columbia.

WILLIAM McGIE YOUNG, B.Sc., Associate Member Canadian Society of Civil Engineers, graduate in mechanical engineering of McGill University in 1899, is leaving Ottawa to accept the position of comptroller of water rights in the Department of Lands of the province of British Columbia. Mr. Young was formerly chief engineer of the International Marine Signal Company, and has been recently practising as a consulting engineer, giving special attention to efficiency engineering, factory management and production.

HARRY WEBB has resigned his position with the city of Winnipeg to take up a position with the Canadian Mineral Rubber Company, Limited, as local manager, to succeed Mr. F. G. Pusey, resigned. Mr. Webb was in charge of the several paving plants operated by the city for five years, and during the last three years has been superintendent of all paving work in Winnipeg.

MR. W. W. COLPITTS, M.Am.Soc.C.E., a graduate in civil engineering of McGill University, class of 1899, and for three years associated with the Canadian Pacific Railway, has resigned his position of chief engineer of the Kansas City, Mexico and Orient City Railway to become associated with W. H. Coverdale & Co., of New York City. He is being retained by his former company as consulting engineer.

OBITUARY.

SIR WILLIAM ARROL, the most noted of British bridge builders, died on February 20 in London, Eng. He received his Knighthood in 1896, and was born in Ayrshire in 1839. He constructed the present Tay bridge and the Forth bridge. From 1895 to 1906 he represented Ayrshire in the Commons. He was a Unionist.

The Ontario Good Roads Association is holding its eleventh annual meeting at the Exhibition Buildings, Toronto, on February 26th, 27th and 28th of this month. Further notes of this meeting and the papers read will appear in next week's issue.

ONTARIO LAND SURVEYORS.

The following gentlemen received certification to practice as Ontario land surveyors at the recent examinations,—J. R. Gill, F. J. K. Benner, E. Cavell, R. F. Dynes, D. S. Ellis, S. E. Flood, C. W. G. Gibson, J. B. Hellferth, E. G. MacKay, D. A. Niven, G. L. Ramsey, W. R. White.

The following gentlemen have passed the preliminary examination:—K. Campbell, F. L. Moore, J. R. Scott, W. M. Stone, C. R. Yates.

COMING MEETINGS.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum Chicago, Feb. 26th to Mar. 8th.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—A meeting for the purpose of further discussing "Professional Relations," will be held at the Engineers' Club, 32 West 40th St., New York City, Tuesday evening, 8 p.m., March 11, 1913. Secretary, Eugene W. Stern, 103 Park Ave., New York City.

THE CLEVELAND ENGINEERING SOCIETY.—Regular meeting, Chamber of Commerce Bldg., March 11th, 1913. Illustrated Paper on "Storage Batteries," by H. H. Smith, Chief of Research Dept., Edison Storage Battery Co., Orange, N. J. Secretary, David Gaehr.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual Meeting will be held March, 3, 4 and 5 1913, in the Green Room, Congress Hotel and Annex, Chicago, Ill. Secretary, Will P. Blair.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W. Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase, Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24. Toronto, March 6, 1913 Contents of this issue on page 403

The Canadian Engineer

An Engineering Weekly

GREAT BRITAIN'S MIGHTY WARSHIPS

SOMETHING ABOUT THEIR ENGINEERING FEATURES

Photographic illustrations used by permission of the Right Honorable Winston Churchill, First Lord of the Admiralty, and supplied by courtesy of Messrs. Gale & Polden, Portsmouth, England.

Owing to the political situation in Canada at the present time, the navy of Great Britain is now very much before the public, and from recent actions, it might be intimated that the time is not far distant when the navy of Great Britain will be the navy of Greater Britain and become an imperial affair.

The columns of a technical newspaper are not a proper place to discuss the question from a political or patriotic viewpoint, but there are so many phases and aspects of the British navy and so little, apparently, known in Canada regarding its workings that it is but reasonable to assume that certain mechanical features will prove interesting reading to the patrons of *The Canadian Engineer.*

The fighting ship of today is a distinctly modern creation, and holds nothing in common with its predecessor excepting the ability to float. It is designed for one specific purpose, fighting only, and toward the accomplishment of that purpose the entire design is directed, but the following factors must receive due consideration:—

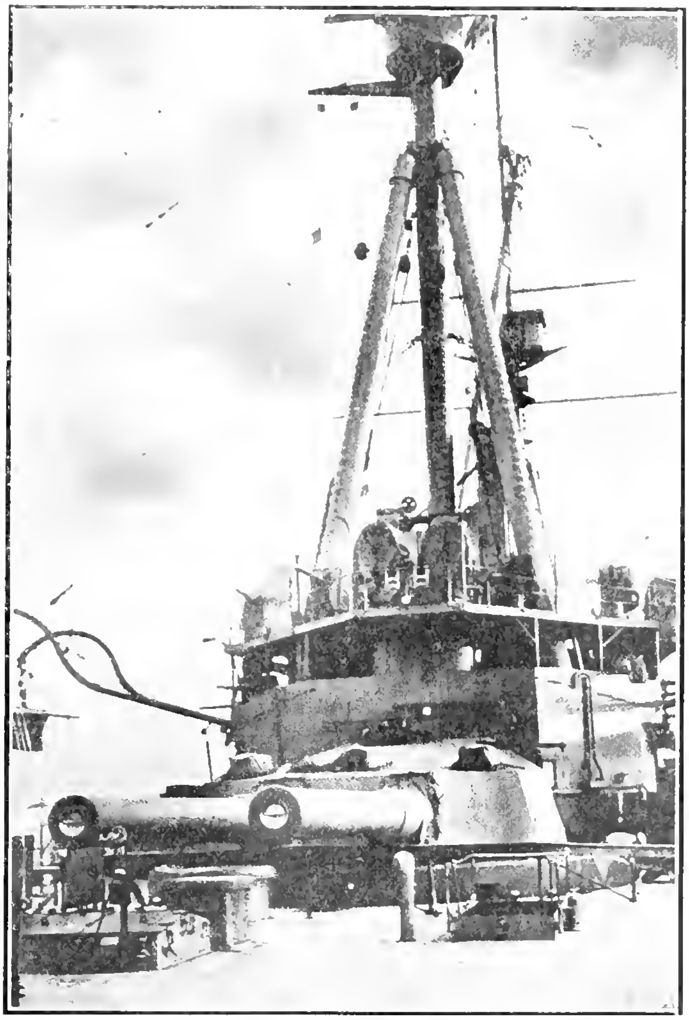
(1) The ship must carry sufficiently heavy armament to give a degree of striking power equal to anything that is likely to be met with in opposition during a time of action.

(2) The ship must have armor of sufficient strength and disposed about the vital spots in such a manner as to withstand sustained gun fire.

(3) The ship must have speed enough to enable it to manoeuvre against any hostile ship of its own type on terms of equality, if not superiority.

(4) The ship must be given sufficiently large storage of fuel—technically known as coal endurance—to enable it to keep the sea for lengthy periods and make long passages without the need of replenishing the bunkers.

(5) The ship must be given an ample ammunition endurance.



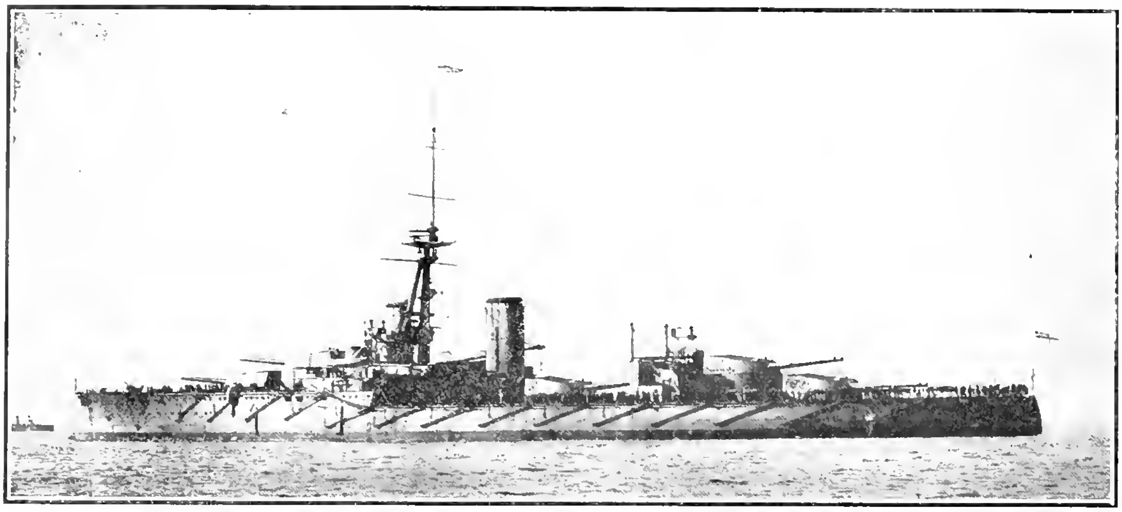
A Battery of Twelve-inch Guns and Their Fire Control Station in the Rear.

(6) The living quarters of the crew must be of the best, especially regarding sanitation.

(7) The ship must be absolutely seaworthy; this is the most important consideration of all, for after the entire matter is threshed out a battleship of the present day is only a floating foundation for heavy guns.

The naval designer has a difficult task before him when he attempts to reconcile all the foregoing conditions in the design of an ideal ship, as they are of such a contradictory nature, and if a battleship of given tonnage were armed more heavily than any ship previously afloat, the additional weight imposed by guns and mountings would have to be saved in some other point—in armor, for instance. The result of such a design would give a ship of great aggressive powers, but exceedingly limited in its own powers of resistance. If unusual speed is desired this involves increases in engine room, increased boiler space, and increased coal storage to maintain the steaming requisitions of the design. As the total tonnage is a given factor it follows that when one phase of the ship is made abnormal some other phase must be weakened; just which factor he may best reduce and in what manner the reduction may best be brought about are a few of the problems that the naval architect must contend. Some of these problems, however, solve themselves; an example will make this clear.

The battleships of the "Admiral" class which were much in vogue during the early eighties, were a type of ship that the admiralty hoped could be developed by enlargement in every detail as time and other conditions warranted; consequently this development continued until guns of 16¼-inch bore were mounted. It has been suggested that the corresponding increase in hull design was not thoroughly understood for of the three ships mounting these ponderous weapons, only one is on the sea to-day; this is the "Benbow." The fate of the "Victoria" is known to history, and the other member, the "Sans Pariel," is on the scrap heap. It was readily seen that development along this line was not practical, for the guns had a weight of 110 tons each, and this, added to their mountings, made the ship top-heavy, and then, again, this gun only possessed a muzzle energy equal to 2,087 foot-tons. The introduction of improved explosives and gun manufacture, which followed soon after the completion of these ships, resulted in an increase of efficiency of smaller guns, and in this manner the gun weight was reduced almost 50 per cent., with an increase of "smashing power."



H.M.S. "Orion,"
one of the most powerful battleships afloat.

The British warship differs from all other type of fighting ship in the degree of all-round fighting qualities. It is not so fast as a cruiser, and does not need speed: the object of a British warship is to get at the enemy, and not to run away.

Some few years ago, there was not such a marked line of separation between the battleship and the cruisers as now exists between the ships of the Dreadnought type and the modern cruiser. H.M.S. "King Edward VII." is probably the foremost example of a pre-dreadnought type of British warship, and yet the original "Dreadnought," though only 1,550 tons larger than the "King Edward VII.," has about 60 per cent. more smashing power and 33 per cent. more capacity of resistance, while several of the latest Dreadnought types could double these rates of increase.

With this rapid increase of power comes the rapid increase in the process of obsolescence, and twenty years is now regarded as the extreme maximum period of usefulness of a modern battleship; this short expanse of time is a marked contrast to the days of Nelson and his old wooden ships, for the "Victory" was fifty years of age when she entered the battle of Trafalgar, in 1805, and still floats in Portsmouth harbor, doing formal duty as the flag ship of the commander-in-chief of Portsmouth.

The primary business of the battleship is clearly indicated by the design, and the title and the work expected from a battleship squadron does not differ to any great extent, excepting the increased strength of the compound over the unit. It is a well understood axiom of modern sea warfare that however the course of the campaign may be influenced by brilliant desultory tactics, such as the guerilla attacks of cruisers and destroyers and such like, the great final issue may only be decided by the battle squadrons alone, and so long as they continue to float upon the sea the nation whose flag they bear is not beaten; when the battle squadrons are crushed the sea power of that nation is hopelessly broken.

Battleships form the first fighting line of all sea power. It is their duty to meet and engage, and all sea strategy is shaped to bring about this result on the most favorable terms. A meeting of hostile battleships may not of necessity be decisive, but when it is decisive and one side has no more effective battleships left, then the sea power of that nation is like the broken reed referred to in ancient history. The cruisers of a battleshipless nation may still manage to keep the sea and inflict serious damage to the commerce of the conqueror; and destroyers may make an occasional swoop with serious consequence, but the fact remains that without battleships organized sea warfare is at an end.

The power of the battleship then, depends upon its degree of gun fire and its resistance to hostile shells, and to maintain the latter condition the ship is armored; armor being a generic term embracing all the protective features of the ship. The principal heads under which the armor of a battleship may be classified are: (1) broadside protection; (2) armored bulkheads dividing the ship into watertight compartments; (3) protection of gun positions and all fighting stations, and (4) the protective deck.

The broadside armor is by far the most important feature in the defensive arrangements of any warship. It means the protection of engines, boilers and magazines against the direct impact of projectiles delivered broadside which, of course, presents the largest area of target to the guns of an enemy. In the modern designs the armor is carried from end to end and the greatest thickness is maintained along the central section which encloses the magazines and propulsion mechanism, the extremities are fairly thin. In a ship of the Dreadnought type this belt of armor is composed of a strip of Krupp steel, 11 inches in the thickest part and tapering to 6 inches at the forward end and 4 inches thick at the stern. A very much wider area of armor plate is always disposed below the water line than above; the belt being carried downwards to a depth of ten feet. Experience has shown that the high velocity projectile of a modern naval rifle, on being fired at a sufficient angle of depression to strike a ship well below the surface, either rebounds or becomes acutely deflected on touching the water. If the protective belt is carried to a depth of ten feet from the displacement line the chances of a ship being pierced from below are negligible.

The rapid improvement of naval guns rendered it im-

perative that the invulnerability of armor should be increased without a relative increase in weight; the Harvey process was the first step in this direction, but nearly all the British ships of to-day are armored with Krupp steel, which has a tensile strength of almost 50 tons per square inch, and is hardened by small injections of nickel, chromium and manganese. The Krupp plate, in its shell resistance qualities, has a figure of merit of about 2.5 as against 1.25 for compound armor which was supplied on armored ships built previous to 1890. The compound armor consists of a wrought iron plate attached artificially to a steel face of about half its own thickness; the result being a plate with the hardness of steel and the toughness of wrought iron on the back, the combination being designed to break a shell up without cracking the armor plate. Thus it is seen that the 11-inch belt of a modern Dreadnought ship offers more resistance to hostile gun fire than the 20-inch belt of the "Trafalgar" (a ship that was considered a wonder when commissioned in 1887) and this is accomplished with a reduction of about 47 per cent. in the weight.

In a modern British battleship a second section of broadside armor is carried above the belt mentioned above and is meant to protect the citadel or redoubt. This belt is carried upward from the midship section as high as the level of the main deck and is composed of 11 inches of Krupp steel in the centre tapering to 8 inches at the extremities; it encloses the turret mountings and the upper portions of the coal bunkers. All the main armor and the lower part of the upper belt is backed by a solid wall of coal nine feet thick.

The armored bulkheads subdivide the ship transversely into sections and these spaces are again subdivided by a central fore-and-aft bulkhead below the armored deck. In the Dreadnought type of British battleship the armored transverse bulkheads below the main deck—which is nine feet above the water line—are all unpierced excepting by pipes and wires and ingress and egress to these various compartments is effected by elevators.

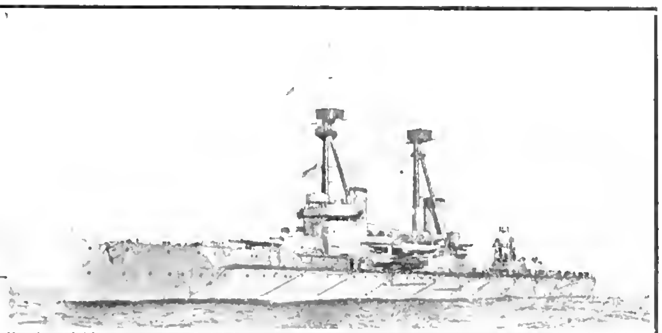
In the protection of guns the aim is to secure the maximum of safety for the crew and the firing mechanism, coupled with the greatest possible mobility in training the weapon over the widest possible arc of fire. The barbette, which is almost exclusively used in the protection of guns, is a circular fortress of steel with a bomb-proof top, the whole revolving upon a shaft which goes right down to the bed of the ship. (Fig. 1).

H.M.S. "Orion," considered to be the most powerful all-round fighting ship in service, mounts ten of the 13.5-inch gun of the new design. This gun weighs 76 tons and throws a projectile weighing 1,250 pounds with a muzzle velocity of 2,599 feet per second, and with the usual firing charge of 293 pounds of cordite is capable of penetrating 51¼ inches of wrought iron at a distance of 6,000 feet from the muzzle. It is reported that the admiralty have a still further improved 13.5-inch gun that has a muzzle velocity of 2,850 feet per second, and operates on a charge of 430 pounds of cordite without injury. This has not as yet been mounted, but according to report is an effective check against the proposed 14-inch gun mentioned in the estimates of certain foreign powers. The 12-inch gun, which we illustrate in Fig. 1, is the standard heavy British naval gun, and is mounted in nearly all the ships now in commission. This gun weighs 69 tons and throws a projectile of 850 pounds; the muzzle velocity of this weapon is 3,010 feet per second, and the extreme range is 25,000 yards, but its most dangerous range is given at 6,800 yards, at which point the velocity of the shell and its explosive properties harmonize to the best advantage.

A modern British Dreadnought carries 800 projectiles for these monsters, and the shell delivery apparatus is so arranged that one shot per minute could be flung from each gun. This rapidity of fire would not be feasible, however, owing to the eye-stinging vapors and the benumbing effect of the "back-blast" upon the crew. Guns of 10 inches, 9.2 inches, 7.5 inches and 6 inches are also disposed about the modern ship and all are considered large guns. The 4.7 and smaller weapons are regarded as "mosquito" armament, and are used only for close quarters, repelling torpedo craft, and by the marines when making land attacks.

H.M.S. "Invincible,"

one of a powerful line of battle cruisers that would keep the lines of commerce open during a time of hostilities, while the battleships were blockading the enemies' ports.



H.M.S. "Temeraire,"

one of many of Britain's latest Dreadnoughts. Note the tripod construction of the masts, they are constructed thus to allow great steadiness in the fire control tower situated half way up. Two legs of these supports could be shot away and the mast still remain rigid.

The fire control of each and every weapon on a modern British warship, excluding the hand rifles and officers' revolvers, is under the direct control of the gunnery officer in the fire control station. A series of electric wires and a switchboard enable him to communicate by telephone and other means with every gun turret on the ship. In order to reduce the risk of the fire control station from being shot away to the smallest possible limit, the fire control station is mounted on a steel tripod, each leg of which will effectively support the platform for a time, should the other two members become damaged. These tubes are hollow and the station may be reached by ladders secured to the inner surface.

The cost of a modern super-Dreadnought may be taken as follows:—

Hull	$2,386,000
Boilers and machinery	2,000,000
Searchlights and electrical fittings	400,000
Boats	40,000
Armor plate	3,240,000
Five barbettes and ten guns	3,000,000
Secondary armament of six-inch guns	400,000
Five torpedo tubes	200,000
Total	$11,666,000

PLANT EQUIPMENT.*

By F. E. Ellis.†

A score of years ago road building was a very simple business, requiring only a small amount of plant and very little expense was incurred by anyone who wanted to enter into it, and one in the business could withdraw from it at any time without sustaining a great loss due to the amount of capital tied up in the plant. During the last twenty years, the method of road building has gradually changed, until the plant now required by a contractor is large and varied, and the expense attached thereto is enormously large in proportion to the amount of work done per year.

It has become a business in which one should not enter without considering thoroughly the kind and amount of equipment required to do the work that he is contemplating, and only after a careful estimate has been made of the expense of plant and the proportionate charges that should be made for the same upon the work on which he is bidding. One must also realize that once in the business, he must remain in it for many years in order to get back the cost of his equipment, or else be willing to take a loss on the sale of it upon retiring. In other words, it is not a business that a man should enter upon with the idea of its being temporary, but with the idea of its being permanent. Failure to understand or obey this principle has been disastrous to many contractors. If the proper plant charges are not made, the contractor is deceiving himself just as surely as did the kind old lady who gave gingerbread to all the children in the neighborhood, and thought it did not cost anything because she had everything in the house to make it of.

The kind and amount of equipment which is required for building a road will vary in the different classes of roads to be constructed, and in order to make a correct estimate of the cost of equipment and the expenses incidental thereto, it is necessary to know the class of road which is to be built. For example, I am going to show you just what it actually costs to equip a road with proper construction plant. The road built was six miles in length, and surfaced with local stone grouted with bituminous binder. The stone was obtained from a quarry which was situated so that the average haul was about two miles. The whole contract amounted to $60,000.00. A contract of this size is considered an average season's work for one gang of men and one set of equipment. I am going to omit from these calculations the cost of small tools, such as picks, shovels and scrapers, and confine myself to larger items of wagons and machinery. The total cost of equipment was $18,240.00 or 30 per cent. of the contract price. The interest on the cost of equipment at 6 per cent. and depreciation at 10 per cent. per year makes a total of $2,918.40 for fixed charges on equipment, necessary to do $60,000 of work per year, or approximately 5 per cent. of the amount of the contract. Most of the expense of equipment was chargeable only to a few items in the contract which included the surfacing. The contract price for these items amounted to approximately $32,000. The first cost of the equipment used in the work covered by these items was $16,445 or 51 per cent. of the work done. The interest and depreciation upon the same amounted to $2,631.20, or 8.2 per cent. of the amount of the work done.

This I believe to be a fair estimate of the amount of equipment and the charges which should be made in order to be safe in estimating upon work of this character. There is hardly any business conducted in which the investment for equipment is so large and the expense due to depreciation and upkeep so great as in road building. Every engineer and contractor in making estimates ought to take these charges into consideration, and contractors who expect to go into the road building business, should make a careful estimate of the amount of plant required and the expense attached thereto. It is not a business in which a man can expect, in these days of keen competition, to make enough profit to pay for a plant in one season's work, and a man entering upon this kind of work must expect to stay in the business a long time before the equipment can be paid for out of the earnings. Road building machinery should only be purchased after a thorough investigation, especially in regard to the liability of breakdown and the expense of the up-keep. The expense of repairs on road building machinery is very small in comparison with the loss which is occasioned by the disorganizing of working crews due to breakdowns. In deciding upon the purchase of machinery, too much weight should not be given to the item of first cost, as the more expensive machine in first cost may be a far cheaper machine to operate and may be depended upon to do its work day in and day out, where a cheaper machine, although it may not break down, is very liable to do so.

In this discussion of road building equipment, I am not going to make any recommendation. I do not expect that my remarks will meet with the full approval of any of the machinery men or the contractors. We all know that if a man purchases an automobile that whatever kind he purchases, be it a one-lunger or a six-sixty, that particular kind is the only automobile worthy of consideration, and it can travel more miles per day than any other make, with less gasoline and expense of up-keep, and the same views are taken by a man who purchases road building machinery. I am therefore only going to give you my own views, which are the result of personal experience.

Wagons.—Four kinds of wagons have been largely used upon road work. The four-wheeled bottom dumping wagon, the four-wheeled two-horse tip cart, the two-wheeled one-horse tip cart and the four-wheeled slat wagon. The slat wagon offers no advantages over the other type, except they are a little lower and easier to load. This advantage is altogether outweighed when the time lost in dumping and turning around is taken into consideration. The single horse tip cart is very economical on short hauls and for work in contracted space, and for making end and side dumps on embankments, or in hauling stone from the quarry to the crusher. The four-wheeled tip cart hauls and is handled very easily on road work, but the weight being all on the hind wheels it is very destructive to road surface and sub-grade, and much time is lost in dumping and righting the wagon. The bottom dump wagon can be used anywhere that the two-horse slat wagon or tip cart can be used, and is more economical than either, the expense of maintaining roadway being very much less than with the other kind. Material can be dumped more quickly, it not being necessary to stop while dumping, and the material can be distributed to a better advantage than with any other type of wagon. Any wagon used on road work should have tires not less than four inches wide.

Road Machines.—A road machine can be used to advantage in digging side ditches, scraping shoulders and making light cuts in the roadway. A machine for this purpose should be built strong enough to be hauled with a steam roller or traction engine without danger of breaking the machine, and also be equipped with a steering device, so that the machine may be worked outside of the travelled roadway

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

† Manager, Essex Trap Rock and Construction Co., Peabody, Mass.

while the roller or traction engine is working upon the firm travelled way.

Stone Crushers.—Three types of stone crushers have been used to a great extent in road building—the gyratory type, the jaw type of the Blake pattern and the jaw crusher of the cam-shaft and roller type. The gyratory type is not very well adapted for portable plants on road work, as the crusher opening is so narrow that the stone requires too much sledging in order to properly feed to the crusher, and the crusher opening is so far above the ground that it requires either a pit or an extremely high dumping platform with a long incline in order to get the stone into the mouth of the crusher. They are also complicated and expensive to keep in repair for work in the eastern part of the country, as it is a long way from the source of supply of the repair parts. For permanent plants where the stone breaks well in blasting, they are a very economical machine.

The advantages of the Blake pattern are the extreme simplicity, there being a less number of reciprocating parts and a less number of bearings which require oiling, than in any other crusher. There is a wedge adjustment by which the crusher opening may be regulated without stopping the crusher. This is an important feature, where enough fine stone must be dumped along the shoulders of the road ahead of the bottom course, as in the case of grouted bituminous work. There is only one tension rod and one spring to keep in adjustment and repair. There are no bearings into which stone clips and dust are liable to enter. This type of crusher I have found to be very economical to maintain and is extremely reliable.

The disadvantages of this type are that for the same size opening, the crushers weigh more than the other type of jaw crushers. They are not so easily transported and handled, the situation and size of the fly wheels in reference to the crusher make it more unhandy to dump close to the crusher than any other type. As a rule the first cost is in excess of the other type of crusher.

The advantage of the cam shaft and roller type crusher is its light weight, which makes it easy to transport and set up, low fly wheels, situated so that the stone may be dumped much closer to the crusher opening than in the Blake type, low first cost and the quick delivery of repair parts. The disadvantages are that it is much more complicated; has more moving parts, more springs and tension rods, than the Blake type. There are more bearings to be lubricated, and the toggle lever shaft is generally situated so that chips and dirt can enter into the bearings. No adjustment can be made regulating the opening of the jaws without removing the toggle which can only be done by shutting down the crusher. Both crushers of the jaw type here mentioned will produce about the same amount of stone for the same size receiving opening and require about the same horse-power to run. All crushers should be fitted with manganese steel jaw plates, as experience has shown that these plates will last about three times as long as the first-class chilled iron plate, and are unbreakable, whereas the chilled iron plate may break or wear out in pockets after running a very short time.

Most all the crusher manufacturers make complete plants composed of bins, crushers, elevators and engines, which are mounted on wheels and can be loaded upon freight cars without being knocked down. Plants built in this style are very economical to handle and set up and are adapted to nearly all kinds of work requiring crushed stone. Where a traction engine is used for hauling stone away from the crusher, it is more economical to have larger bins and longer elevators than are generally furnished with a strictly portable outfit, as it is necessary to have storage capacity in the bins large enough to load a train of traction cars without waiting for the stone to be crushed. On a good many of these portable outfits, the screen plates and elevator buckets are made of too thin material to wear well, the elevator buckets wearing and rusting away quite rapidly. Unless specially ordered the sprocket wheels and gears are usually made of cast iron. The small sprocket wheels and beveled gears, I think, should be made of manganese steel.

Crusher Engines.—Crusher engines should always be large enough to have a surplus of power over and above that which is ordinarily required to run the crushing plant, and the boiler should have additional capacity large enough to supply steam for a steam drill, as in a great many cases, if this is not done, an additional boiler will have to be provided. Most of the states have laws which govern the construction and inspection of boilers, and in the states that have no laws now regulating the construction of boilers, the question is being agitated and undoubtedly in a few years there will be such in most of the states, and as road building has become quite an interstate business, and the machinery is transported from one state to another, care should be taken to procure a boiler which will pass state inspection. I believe that any boiler which is built in accordance with the Massachusetts standard can be used in other states, but there are many boilers which can be used in other states which cannot be used in Massachusetts. Plants equipped with boilers built to the Massachusetts standard, will cost more than boilers usually furnished with crushing plants. These remarks apply as well to road rollers, or any boilers.

Hauling Engines.—Where there is enough work to keep a hauling engine busy and suitable provision can be made for loading and unloading quickly, a hauling engine may be used to advantage, and is about 50 per cent. cheaper than hauling with horses. There is still an opportunity for improvement in hauling engines, especially in regard to gearing and traction wheels, most of the makers using cast steel gears that are uncut and very rough, and which wear very quickly. They also use a built-up riveted or bolted wheel with rolled steel rim. These wheels are generally a source of trouble, as the spokes get loose and break where the travelling is rough and stony, as it is on most construction work.

Road Rollers.—There is no class of machinery used in road building in which there is so wide a difference in construction and design and first cost as in the steam rollers. They may be obtained in most any shape or size or design that can be thought of. I think that it is generally conceded by road builders, and it has been my own experience, that a double cylinder steam road roller is better adapted for road construction than any other type. There is no class of road building machinery which has been so highly developed. The wide variation in first cost of the different steam rollers makes it very difficult for a contractor or town official to make up his mind which one ought to be purchased. There is almost as much difference in road rollers as there is in watches. You may purchase a watch for a dollar which is liable to keep good time for a year and it is liable not to do so. You may purchase a watch which costs almost any price, and in every case you will probably get just what you pay for. As a general thing, the higher the price up to a certain limit, the more dependable the watch is, and the same rule applies to road rollers. There is no road building machinery sold, that I know of, upon which an exorbitant profit is being made. In looking over a road roller with the view of purchasing, particular attention should be given to an investigation of the gearing and wheels. You can tell by the looks of the wheels and gears upon the machine which has been in use, whether or not that machine is going to do your work day in and day out as it ought to. A set of rear wheels should last, under ordinary service, at least ten years. I have wheels which have been in service fourteen years and

are good, I think, for one more. The gearing on steam rollers should be of steel and cut and fitted as nicely as in any high-class automobile construction. Gears should be closed so as to exclude dust.

This paper might be extended indefinitely, going through all the different kinds of machinery required for the different kinds of road work, but I am going to conclude, as I have touched upon the equipment that is common to all road construction, whether it be water-bound macadam, bituminous macadam or concrete.

THE V-NOTCH WEIR METHOD OF MEASURING WATER.*

By Robert Yarnall.†

Attempts to measure accurately and to record automatically the flow of water through pipes or channels have been made from time to time with varying results as to accuracy and convenience. This paper will attempt to show results obtained by the simple and practical V-notch method of measurement, which though not new, seems now to be meeting with marked success, both abroad and in America, in power plant measuring problems. Tests of the accuracy of this method of measurement have recently been made in America and the data collected are here presented to show the degree of accuracy attainable.

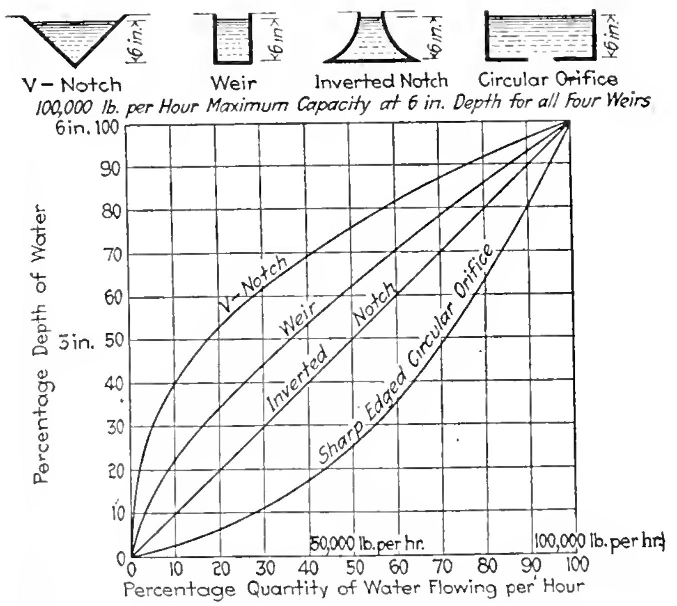


Fig. 1.—Curves Showing Comparative Accuracy of Different Types of Weirs Under Different Rates of Flow.

The instrument employed in the tests is the Lea V-notch recorder, an apparatus which depends on the laws governing the flow of water through weirs. These laws have been found to work with extraordinary accuracy, but it is only comparatively recently that they have been turned to account in measuring the widely varying rates of flow, both hot and cold, met with in power plants.

The most common forms of weir are the plain horizontal sill and the sharp edged rectangular notch. The former of these has the full width of the stream or channel and is without end contraction, the formula used in connection with it being that of Francis:

$$\text{cubic feet per second} = 3.33\ LH\ \sqrt{H}$$

where

L = The width of the weir in feet.

H = The head of water passing over it in feet.

The latter is a sharp edged rectangular notch of less width than the channel or stream and therefore has end contraction. The formula used in this case is

$$\text{cubic feet per second} = 3.33\ LH\ \sqrt{H} \times C$$

where

L and H are the same as before.

C = a constant which depends on the ratio of the width of the weir to the width of the channel.

Although these two formulas give a fair degree of accuracy, there is another in which the accuracy is very nearly 100 per cent. This is Prof. James Thomson's formula for the sharp edged V-notch weir:

$$\text{cubic feet per minute} = 0.305\ H^2\ \sqrt{H}$$

where

H = The height of the notch in inches, the angle of the notch being 90°.

Table I. gives the flow of water through 90° V-notches for each inch of head, up to and including 15 in., calculated by Thomson's formula.

Table I.—Flow Through 90° V-Notch Weirs.

Depth in notch, in.	Flow per hour, lb.	Depth in notch, in.	Flow per hour, lb.
1	1,140	9	277,900
2	6,480	10	361,740
3	17,830	11	459,030
4	36,610	12	568,720
5	63,940	13	694,710
6	100,860	14	836,110
7	148,290	15	993,510
8	207,060		

The section of the flow through the V-notch is at all times the same shape, though the area may vary, and this constancy of form tends to simplify the formula and make it accurate. This form of notch is also especially adapted for measuring smaller quantities of water than the rectangular weirs, as shown by the curves in Fig. 1, which give a comparison of the accuracy of the different types of weirs at different rates of flow. Another property of the notch is that its angle may be less than 90° without impairing its efficiency, which enables it to be used to measure very small quantities of water.

It was for these reasons, as well as for its accuracy, that the V-notch was adopted for use in connection with the Lea recorder, a sectional view of which is shown in Fig. 2. It will be seen that a float spindle, rigidly attached to a float which rides on the surface of the water flowing over the V-notch, passes up through the bottom of the instrument case. A rack on this spindle engages a small pinion upon the axis of a drum revolving between centres. Upon the body of the drum is a screw thread, the contour of which is the "curve of flow" for the V-notch in connection with which the recorder is used, and as the flow through the notch increases rapidly with the depth, the pitch of the screw increases in the same proportion. Above this drum is a horizontal slider bar, supported on small pivoted rollers and carrying an arm, at the upper end of which is a pen or pencil point in contact with a paper chart upon a clock-driven recording drum, which revolves once in 24 hours. As the float rises or falls the drum spiral is rotated, and its motion

*From a paper read before the American Society of Mechanical Engineers at its annual meeting in New York City, December, 1912.

†Mechanical Engineer Yarnall-Waring Co., 1109 Locust St., Philadelphia, Penn.

is imparted to the slider bar and pen arm by means of a saddle arm projecting from the latter and engaging at its lower end with the screw thread. On the body of the spiral drum is a graduated scale adjacent to the screw thread and computed in pounds per hour. It is thus seen that the drum serves the double purpose of rectifying the motion of the pen so that it moves equal distances for equal increments in the rate of flow, and of providing a magnified scale for making an accurate observation of the rate of flow at any moment.

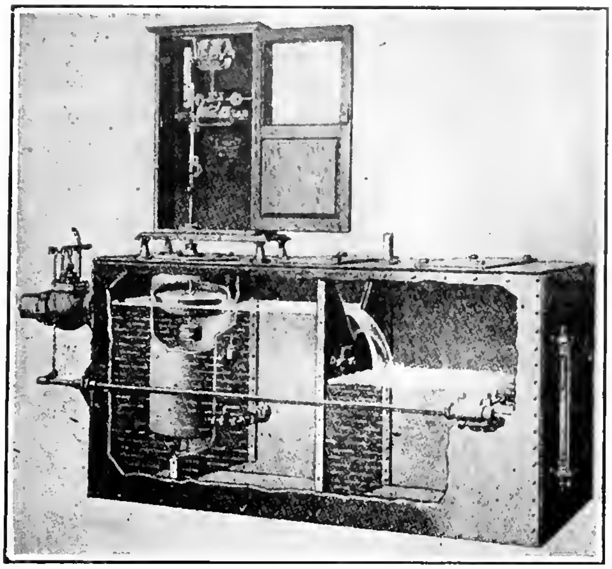


Fig. 2.—Sectional View of V-Notch Weir Meter with Lea Recording Mechanism.

The apparatus has the following advantages:

a. It is simple and hence dependable.

b. Its operation is continuous.

c. There are no moving parts in contact with the flow except the float which is in a chamber by itself and not in the path of the flow.

d. Collections of sediment and deposits of scale do not affect the accuracy.

e. Owing to change of density of the liquid being measured, due to changes in temperature, the float which actuates the recorder is immersed more or less, depending upon this change of density, and the recorder and the float are so constructed that they compensate automatically for these changes in temperature over a wide range.

f. By making the tank of ample proportions a considerable interval of time takes place between changes in the head on the weir, so that the recording apparatus has a chance to adjust itself to changes in the rate of flow, thus giving a chart very easy to measure with the planimeter.

g. It is always placed on suction side of pump, hence it is available at all times for inspection, cleaning and repairs.

Like the Venturi meter and the Pitot tube, the V-notch recorder is a continuous flow meter, but unlike these it is not dependent for its accuracy on velocity changes, and hence its record is not subject to the fluctuations due to sudden changes of velocity head observed in these meters while measuring rapidly changing rates of flow. Perhaps the greatest advantage of this method of measurement is found, however, in the way by which it may be checked independently of the recording mechanism. The operator may construct alongside of his recorder an independent "hook" gauge or use the graduated vertical scale and pointer on the extended float rod in the instrument, and can observe from time to time the number of inches head on the weir. By substituting these values in Thomson's formula, the rates of flow as shown on the recorder chart may be checked quickly and accurately. Thus the operator need not depend upon the recorded result until he is sure that it agrees with the

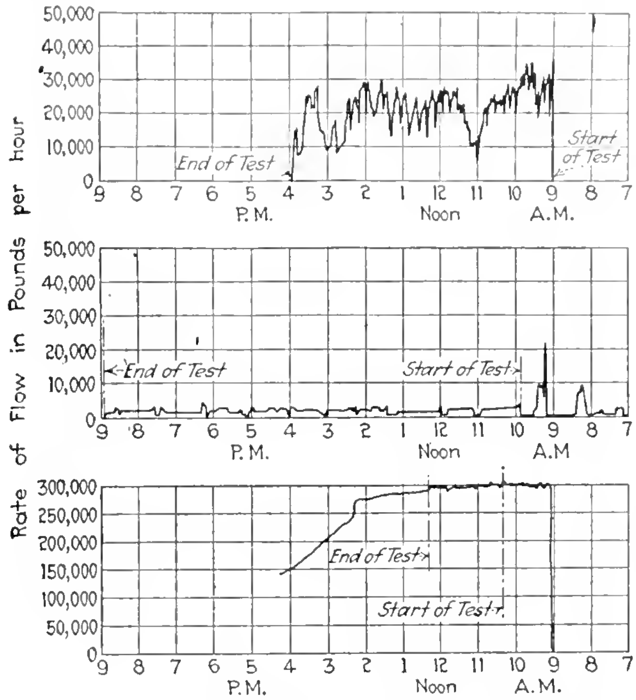


Fig. 3.—Records of Tests on V-Notch Weir Meters.

figured result from his hook gauge readings. It is believed, therefore, that the V-notch with its tank is the most satisfactory testing set that could be devised for measuring water under varying conditions of temperature, continuity of flow, and rate of flow.

The tests mentioned in the opening paragraph of the paper were made at Dartmouth College, Philadelphia, and

Table II.—Results of Tests on V-Notch Weir Meters.

Location	Dartmouth, Col.		Phila.	New York City.				
Date (1912)	3-23	8-2	8-9	4-19	4-20	4-22	4-23	4-24
Duration of test (hr.)	6.25	10.2	1.96	5	8	13	8	8
Temperature of water (F.)	Var. 160°-195°	Var. 160°-195°	Var. .72°-74°	......	......	......	......	......
Corrected weight of water by tank (lb.)	143,841	41,625	596,867	291,965	266,009	557,974	352,725	352,725
Corrected weight of water by meter (lb.)	145,538	413,957	602,270	290,525	267,260	557,775	351,501	352,231
Error of meter (lb.)	+1697	—229.3	+5403	—1440	+1251	—199	—1224	—494
% error of meter	+1.18	— 0.55	+ 0.9	— 0.49	+ 0.46	— 0.03	— 0.34	— 0.14

— = low reading. + = high reading.

New York City. At the first location there were two tests, one in the winter and one in the summer, conducted by the engineers of the college, Messrs. R. D. Kimball Co. The graphic charts of these two tests are shown in Fig. 3, where the top chart shows the record of the winter test, the middle chart that of the summer test, while the record of the Philadelphia test is given in the lowest chart.

The winter test at Dartmouth College was made at the normal running load and took care of all the natural fluctuations in the returns from the heating system, which was being taxed to its utmost by an outside temperature only slightly above zero. These fluctuations were due in part to poor control of the return water from the heating pipes at the new Gymnasium, and in part to the small water-storage capacity of the receiver. The summer test was later run with the same apparatus as the first test, but the rate of flow and amount of fluctuation were greatly reduced because the Gymnasium heating system was out of service. The Philadelphia test was made with water of considerably lower temperature and much higher rate of flow. Also in this case the amount of fluctuation was comparatively negligible. The tests at New York were of longer duration and employed a meter of the larger capacity used.

In Table II. is shown the comparison of the principal data obtained in these three sets of observations and from this table it is apparent that the V-notch weir method of measurement, using the Lea recording mechanism, can be depended upon to within about 1 per cent., even in extreme cases of fluctuating character of flow and changing temperature.

ONTARIO'S SALT SUPPLY.

The brine wells of the south-western peninsula of Ontario last year yielded 88,689 tons of salt, the value of which was $430,835. In 1910 the output was 84,071 tons, worth 414,978. The industry gave employment to 216 workmen, whose wages amounted to $121,477. There is a steady demand for this staple article, mainly for preservative purposes connected with food products, etc., but this demand is easily satisfied and does not seem to be increasing. Its requirements are small in comparison with the abundant supplies of raw material, which is present in enormous quantities. Salt constitutes the basis of a number of products of great importance in the industrial arts, connected with one or other of the elements composing it. From chlorine may be built up hydrochloric acid, bleaching powder and a variety of other articles, while the compounds of sodium, such as carbonate and bi-carbonate of soda, sodium nitrate, etc., play perhaps even a larger part in manufactures, states the statistical review of the Bureau of Mines, compiled by Mr. T. W. Gibson, Deputy Minister of Mines. A plant for the manufacture of caustic soda and bleaching powder from salt was established at Sandwich by the Canadian Salt Company, and began operations during the last week of 1911. Some inquiry has also been made on behalf of a European firm of explosives manufacturers as to the availability of salt supplies required for the sodium nitrate used in making their product, which is finding a market in the mines at Cobalt.

About one-half of the salt made in Ontario is produced by the Canadian Salt Company, whose plants are at Windsor and Sandwich. Other makers are the Dominion Salt Company, Sarnia; Western Canada Flour Mills Company, Goderich; John Ransford, Stapleton; Ontario People's Salt and Soda Company, Kincardine.

The workmen employed at the salt wells and works numbered 216, and their wages amounted to $121,477.

SKYSCRAPERS ARE MONEY-LOSERS.

Mr. Purdy, president of the Department of Taxes and Assessment, New York City, spoke as follows of high buildings while in Canada lately, before the Canadian Club of Toronto.

Rising out of the present-day tendency to tax land fully, Mr. Purdy said, had come the tendency intensified to put real estate to that use which would make it yield the greatest financial return, but as yet the cities of this continent have failed to realize the necessity of protecting men's liberty against the license of their neighbor—hence the "skyscraper.". Through the failure to restrict both the height of office buildings and the proportion of ground covered by them, light and air had been shut off to the extent of depreciating the value of the properties in the district, while high land values had also been localized in an extremely small area of the down-town district.

Preserve Air Space.—In his official capacity, the speaker had sat at the hearing of some 50,000 applications for lower assessment, and the number of these which were based on the loss of light and air through the disproportionate height of buildings in relation to surface area was astounding. Closely packed tall buildings had resulted in discomfort to the occupants, which caused them to forsake them, and the appeal for lowered taxation had followed. He further attributed to the intense congestion brought about by the erection of such structures, the smallness of the business area where land values are really high. At one point on Broadway, he explained, corner lots 25 by 100 feet in area are worth over one million dollars, while less than 100 yards distant are similar lots which would not command $25,000. "Had we restricted the height of buildings as did the cities of Europe," he declared, "we would have no $25,000 lots, no three-quarters of our business people working by artificial light during the day time, and no streets so crowded that at lunch and supper time it is practically impossible to walk in the opposite direction from the crowd."

As a preventive, he recommended legislation controlling both the height of buildings and the percentage of the lot which they may cover, in order that air spaces may be left between them.

"May I commend you," he continued, "here in this great growing city, which is still in such a position that you can regulate it in time, to look at the pictures of German cities, and to read their building regulations. They are restricting building from the standpoint of utility on the principle that no building may be allowed which will prevent others of the same size around it from receiving their share of light and air."

He further stated that he had recently had opportunity to talk to those who have erected one after another of the recent skyscrapers in New York, and not one of them has made money. Other arguments may not be effective, but perhaps this statement may give pause to some of those who wish to rush you into the erection of large office buildings which are to be the highest in the British Empire.

More Intensive Use of Land.—"With an increase of the tax on land has been an increase in the endeavor to use land for the most intensive purposes," the speaker continued. "Most European countries have recognized that it is necessary to impose the most stringent rules to regulate the height of buildings, and the area of land to be used for office buildings. Both the United States and Canada have been backward in imposing such regulations. They have been loath to impose regulations which would hamper the individual, but perhaps they have overlooked the fact that the freedom of the individual is bounded by the freedom of others, and

that no individual should be permitted to do those things which interfere with the rights to light and health of his neighbors.

Restriction Injures City.—"The city of New York has suffered by this false idea. The limit to the erection of buildings has reduced the value of adjacent properties as a result of this license. We have ruined the appearance of the city, and impaired the health of its citizens, only to reduce the number of its suitable office buildings. Also, we have rendered it practically impossible to get any commensurate value from a great number of lots which are surrounded by these buildings of great height which have shut off their neighbors from light and air which they require.

"German and English cities have enforced ordinances which it would be well for American and Canadian cities to copy. The fact of the matter is that so far as New York is concerned, we have allowed ourselves to reach a condition which is without remedy. I speak now of the Borough of Manhattan. We can still help outlying boroughs, and you have opportunity to help a city which is growing logically and sensibly, but which you should not permit to depend for growth on artificial means."

PRACTICES OF THE WORLD'S BANKS

BY M. P. LANGSTAFF, A.I.A., F.A.S.

As has been the rule, the rate of discount announced by the Bank of England from time to time serves as a guide to the other banks throughout England and Scotland in fixing their rates for loans and deposits. It is, indeed, in a position to compel other banks to raise their rates to the same extent; for, should the London joint stock banks, for example, continue lending at a lower rate, the Bank of England would proceed to borrow all floating money that could be found on the security of consols, and thus create a vacuum, which could be filled only by money from foreign countries.

The Bank of England is the banker of the Government; is the largest issuers of notes, issuing its notes when required in exchange for gold bullion and paying notes in gold coin; and, being the bankers' bank, the weekly returns as to its position form the best possible barometer of the state of trade and credit in the country.

London has often been referred to as the clearing house of the world; for here many of the largest traders make their settlements; here the world's supply of gold finds its natural point of distribution; and here, England herself makes her great loans of capital. The Bank of England, therefore, is the centre of a great system of joint stock and private banks doing an immense cosmopolitan business. These banks keep their chief reserves in the Bank of England, which necessarily, therefore, occupies a position of great responsibility. From the peculiar nature of the business done by these banks, it follows that their liabilities are affected by numerous and sometimes unexpected conditions, whether in England or in any foreign country of importance, and hence they must often find themselves subject to great and sudden demands, which react, of necessity, upon the Bank of England, in which they keep the major part of their reserves. It is seen, therefore, that the Bank of England holds in its charge that on which the solvency of the banks in general, the safety of the commercial public, and the credit of England alike depend.

It has been said that in Scotland credit has been systematized to the last degree, and in this connection it will not be out of place to refer to their system of "cash credits." These, while not directly affecting the money market, perhaps, have yet from the fact that they have played an important part in the development of agriculture in Scotland, tended to affect it in their reactionary and future results.

When a borrower obtains a cash credit from the bank he is permitted to draw money as it is wanted up to a certain sum, being charged interest only for the time and on the amount actually used. As a cash credit is not based upon any completed commercial transaction, it is in reality "accommodation paper." For this reason adequate personal security in addition to that of the borrower is required, the bank thus advancing the loan on its knowledge of the character of the borrower and of the responsibility of his endorsers. Owing to this system, many young men of ambition and character have been enabled to attempt praiseworthy enterprises without the necessity of waiting long years to accumulate money from their own earnings.

If we consider the vast number of securities discounted by the Bank of France and their small average amounts, it must be at once apparent that the bank is a lender on a large scale to the class of small traders. One reason for this is that the bank discounts a great deal of paper on which advances have already been made by the banking house, which are the immediate customers of the bank.

Owing to the policy of the bank in lending in this way to intermediaries, and also direct to the small borrowers themselves, these latter are enabled to derive much advantage from the relief afforded by the maintenance of a fair rate of interest due to this flow of loans at a steady rate from the bank. The bank has also found by experience that the business carried on with the class of small traders is singularly free from loss and generally steady in its movement. Owing therefore, to this class of business, and also to the advantage that it enjoys as a debtor, under the bimetallic system of the Latin Union, the Bank of France has become in specie holdings the strongest bank in the world, and is less affected in times of financial stringency than any other bank.

I have referred before to the elasticity allowed to the Reichsbank in its note issue. Owing to this "elastic limit" it is enabled in a time of financial stringency, when the demand for loans is imperative and the market rate is high, to meet the necessities of borrowers, aud thus quiet the public mind.

Like the Bank of England, the Reichsbank holds a large percentage of the reserves of the other banks. As a consequence, the German banking world is dependent upon it in the event of any extrtaordinary demand. Occupying, as it does, the central position in the German money market, the Reichsbank finds it necessary to be ever on its guard against the dangers of the depletion of its reserve; and a diminution of this reserve is not only regarded with concern by the banking world, but becomes a matter for general uneasiness from the fact that this reserve is regarded as a most important resource for the Empire in time of war. Like the Bank of England, the Reichsbank regulates this reserve by varying its rate of discount, and, as a general rule, seems to have experienced less difficulty than the Bank of England in bringing the outside rates of the general money market up to a close approximate of its own rates.

Under the operation of the reserve system the cash reserves of the national banks are centred in New York. The great structure of bank credit in the United States, resting as it does in a large measure upon the money reserves of the New York banks, has been analogized to an inverted pyramid upon its apex. Financial conditions throughout the whole country are affected by every important fluctuation in the New York money market; and, similarly, the New York money market is affected by every change of any consequence in the demand for money or credit in any part of the country

Great economy in the use of money is the result of the central reserve system, the use of which, however, in the

United States seems attended by certain dangers; but the reasons for these may be assigned to other features of the United States banking system, among which may be mentioned the dominance of speculative influences in the New York money market, the independent Treasury system, and rigidity of the bank note issues.

To the fact that Canadian banks refuse to encourage speculation to any extent whatever may be assigned the comparative steadiness of the Canadian stock markets.

I have before referred to the tendency towards equalization of the rates of interest in all parts of the Dominion, due largely to the branch system and freedom of note issues of the Canadian banks.

THE RATIONAL USE OF WATER IN IRRIGATION.*

Dr. John A. Widstoe.

To all who have dipped ever so little into the history of irrigation, the annual meetings of this Congress appear of great importance. Irrigation is one of the great world-movements for subduing the "waste places" of the earth, and also for solving many of the social problems that perplex mankind. It is not impossible that upon irrigated lands, with their possible small family units, and their fertile soils and abundant sunshine, shall be formulated by actual experience the social ideals that eventually may bring the nations with their legions of human hearts into co-operative peace. This Congress is the only organized body which assumes general interest in all the methods, purposes and results of irrigation.

From its humble beginning in this city, modern American irrigation has grown, until the census of 1909 reports nearly 14,000,000 acres of irrigated lands. One-half of this vast area was brought under irrigation since 1899, and three-fourths since 1889. That is to say, during the last twenty years, three-fourths of the irrigated lands were reclaimed; while only one-fourth was brought under irrigation during the first forty-two years after the entrance of the Utah pioneers into the Great Salt Lake Valley. Clearly, the efforts of the country in behalf of irrigation have increased in geometrical ratio. This interest appears to continue undiminished, so that it can only be a matter of comparatively short time until most of the irrigation waters of the West shall have been brought upon the lands.

There are three main stages in the development of an irrigation project. First, the construction of satisfactory dams and canals in which the water may be stored and then led upon the land; second, the settlement upon the reclaimed land of a sufficient number of people to make full use of the opportunities of the project; and third, the correct use, by the settlers, of the water and land so that the project may be highly and permanently profitable. While these three stages are of equal necessary importance, yet it is evident that the first two, construction and settlement, once accomplished, are practically forever done, but the third, the use of the water, is of annual recurrence, and in the end will determine the success or failure of the project.

This third stage, the use of water, has been given least systematic attention; but with the increasing population under irrigation, it is insistently clamoring for attention. In the arid and semi-arid region, irrigation, under present methods of use, can probably never reclaim more than one-tenth to one-fifth of the total area of tillable land. For our 14,000,000 acres of irrigated land there are at least 500,000,000 acres that must be reclaimed, if reclaimed at all, by other methods. There will always be more land than water in the arid region; and one of the chief concerns of every project should be to cover profitably the largest possible area. The actuating spirit of irrigation enterprise is, or should be, to make possible happy homes for the many.

With this thought in mind let me call your attention to two vital principles of irrigation success. First, the beginning of irrigation wisdom is the conservation of the natural precipitation, i.e., the rain and the snow. Irrigation is not a primary art; it should always be supplementary to the natural precipitation, and should only make up for the deficiency in the rainfall. The progress of dry-farming during the last decade has brought this truth home to the irrigated section. The water which falls from the heavens, even under an annual precipitation of ten inches, is amply sufficient to produce crops, could it only be fully held in the soil. By properly conserving the rain and snow-water in the soil by dry-farming methods, large crops may be grown with small quantities of irrigation water. This is well brought out in a series of experiments conducted during the last ten years at the Utah Experiment Station.

Table No. 1—The Crop-producing Power of the Natural Precipitation.

Yields per acre.	Inches of irrigation water used. None.	5.0 to 7.5.	Per cent. of yield due to rainfall.
Wheat (bush. of grain)....	39	47	84%
Oats (bush. of grain).....	55	64	86%
Corn (bush. of grain).....	44	54	81%
Wheat (pounds of straw)..	3,934	4,526	86%
Oats (pounds of straw)...	2,233	2,274	98%
Corn (pounds of stover)...	3,228	3,888	83%
Alfalfa (tons of hay)......	5,540	7,178	77%
Potatoes (bushels)	97	145	67%

The data in the above table show that approximately 85 per cent. of the yields, under irrigation conditions, of wheat, oats and barley, 77 per cent. of the yield of alfalfa and 67 per cent. of the yield of potatoes, was due to the natural precipitation stored in the soil. This is only a fair sample of what may be done on any irrigated farm if careful soil tillage be practised. If, now, by careful tillage the natural water had been allowed to escape into the air, much more irrigation water would have been required to produce the crops. By the proper storage of the rain and snowfall in the soil, alone, it is possible to extend our irrigated 14,000,000 acres considerably. Therefore, to make our irrigation projects of greater service, the settlers upon them must be taught that irrigation is designed only to supplement the natural precipitation.

Second, the yield of any crop under irrigation is not in proportion to the quantity of water applied. The more water is used in irrigating a crop, the less yield is obtained per unit of water. This has been amply demonstrated also in the long continued investigations at the Utah Station, already referred to. As examples, note the following results obtained with wheat and sugar beets:—

Table No. 2—Inches of Irrigation Water Applied.

	5	10	15	20	30	50
Wheat (bush. grain per acre)............	38	44	46	47	49	49
Wheat (lbs. straw per acre)...............	2,986	3,452	3,954	4,311	4,755	5,332
Sugar beets (tons per acre)...............	14	19	20	21	21	24
Wheat (bush. grain per acre-inch)......	7.56	4.35	3.05	1.86	1.39	0.99
Wheat (lbs. straw per acre-inch).........	597	345	264	172	136	107
Sugar beets (tons per acre-inch)..........	2.76	1.86	1.30	1.06	0.69	0.49

As the water increases, the yield becomes relatively smaller, and if enough water is applied, there is an actual diminution of yield. The studies of the United States Irrigation Investigations under Drs. Mead and Fortier have shown that excessively large quantities of irrigation water are used in ordinary practice. The losses which the irrigated

* Abstract of address before the twentieth National Irrigation Congress, Salt Lake City, Utah.

section has thereby sustained will probably never be known, but unquestionably run annually into millions of dollars.

It is of higher importance than ever before that a reasonable duty of water be established, and that those responsible for irrigation projects, by the education of the farmers as well as by the enforcement of reasonable rules, see to it that such duty is observed. At present, the duty of water assigned by the State Engineers is seldom as low as 30 acre-inches; usually, much higher. It will be a living question, in view of what we are learning concerning the relation between water and crops, whether even 30 acre-inches shall be allowed for one acre of land when it might be made to accomplish so much more if spread over a larger area.

Spreading 30 acre-inches of water over four instead of one acre, the increase in yield for wheat, corn, sugar beets and potatoes was threefold; for alfalfa even more, and for timothy twofold. Increasing foodstuffs in this manner, two and threefold, simply means that from two to three times as many human beings may be maintained upon the irrigated area; and every lover of the West dreams of the day when populous commonwealths shall cover the "Great American Desert." Irrigation is for the many, not for the few.

Table No. 3.—The Crop-producing Power of 30 Acre-inches When Applied to Different Areas of Land

Crop.	Thirty acre-inches spread over. 1 acre.	2 acres.	3 acres.	4 acres.
Wheat (bush. of grain) . .	48	91	132	166
Corn (bush. of grain) . . .	97	188	260	317
Wheat (pounds of straw)	4,533	7,008	10,356	13,204
Corn (pounds of stover) .	10,390	16,558	18,021	28,756
Timothy (pounds of hay)	6,054	7,688	11,739	11,928
Alfalfa (pounds of hay) . .	8,840	15,003	20,653	. . . .
Sugar beets (tons)	21	30	50	65
Potatoes (bushels)	105	373	456	544

By a more intelligent use of the waters already impounded or diverted the irrigated area may be increased largely, perhaps doubled. It is certainly a subject worthy of consideration. True, under the new projects, not yet well settled, there is no scarcity of water; yet in developing the West by irrigation should not the growth be symmetrical? We hope that no completed project will long remain without settlers; should we not be equally anxious that every new settler, from the beginning, use water the right way? In our older sections, water already is scarce; methods for increasing the duty are sought after; in time the newer sections will be in the same condition. Let us learn good habits in our youth, so that we shall have less to unlearn in our maturity.

FORESTERS IN DEMAND.

We note in the Conservation Publication for February an article which we publish herewith. It should be of importance to all those choosing future work and occupation.

The remarkable expansion of forestry work in Canada during the past year is evidenced by the fact that all the men who will finish forestry courses next spring at the University of Toronto were offered employment months in advance of their graduation. If the class were several times as large there would still be no difficulty in finding employment in Canada. The organization of the new Forests' Branch in the Department of Lands of British Columbia and the natural growth of work in the Dominion Forestry Branch, Department of the Interior, are largely responsible for this situation. At the present time the supply of Canadian foresters is far below the demand and this condition will continue for several years at least.

SOME FEATURES OF MACADAM CONSTRUCTION.*

By T. R. Agg.†

Inasmuch as water bound macadam has been written about and discussed so frequently, it would seem that there would be little need to consider it at a time like this. Nevertheless, it is not uncommon to see water bound roads under construction where little attempt is being made to observe the simple and well-known principles of such construction, and that is perhaps sufficient reason for some discussion of those principles at this time.

The well-known characteristics of a properly constructed water bound macadam road are: A well-drained, carefully shaped and thoroughly compacted subgrade; properly shaped side roads and ditches to insure the removal of surface water, and a layer of thoroughly compacted, properly bonded crushed stone, the surface of which has been well keyed together by rolling so that it presents a compact mass of stone of sufficient size to bear the loads that will pass over it without crushing and in which the stones are mechanically locked together by rolling and held in place by means of the dust from the crushed stone which has been worked into the interstices between the stones by means of water and rolling.

In deciding upon the size of the pieces of stone to be used for the upper layer of the water bound macadam road, two things must be taken into consideration—the quality of the stone which is available for use, and the amount of traffic and the weight and character of the loads which will pass over that surface. A road surface carrying a medium or light traffic, of which a small percentage consists of motor-driven vehicles, can obviously be made of smaller sized pieces of stone than a road surface carrying traffic made up of a great many heavily loaded horse-drawn vehicles, together with a large number of motor vehicles.

If the pieces of stone in the surface of the road are so small that the wheels passing over them crush them, it is inevitable that rapid wear will result and that the road will deteriorate quickly. On the other hand, if the surface of the road is made of very large pieces of stone, the traffic will not crush them, nor even wear them with sufficient rapidity to supply fine material to fill the interstices between the stones and keep the voids filled, notwithstanding the action of the elements and traffic. In such a case, the road will become rough and uneven, the surface being made up of rounded stones, which project slightly and make it disagreeable to traffic.

If the road carries any considerable proportion of motor vehicles, the water bound macadam does not prove satisfactory, but a surface made up of fairly large pieces of stone will withstand the action of motor traffic better than one made up of small stones, though the former is less desirable from the standpoint of the user on account of its roughness.

Somewhere between these two extremes, lies the ideal size of stone to use, which is a size sufficiently large to sustain the loads that pass over the road, without breaking, but small enough so that the wear on the surface will furnish sufficient fine material to keep the voids between the stones filled with dust and chips, thereby maintaining a smooth surface.

In the work of the Illinois Highway Commission, it has been found that with the soft limestone available, the size ranging from 2½ ins. to ¾ in., is most satisfactory. When stone of such a size is used it is, of course, desirable to have

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

† Road Engineer, Illinois State Highway Commission.

the surface layer made up of fairly uniform pieces and to keep it free from pockets or patches of the finer material. This can be secured by harrowing the stone thoroughly, after it has been spread, by means of a heavy, stiff-toothed harrow. The harrowing not only brings the larger pieces of stone to the surface, but shakes down any pockets or patches of finer material that may occur.

The stone which is to be used for the wearing course in a water bound macadam, is, as has been mentioned, thoroughly locked together by means of the roller so as to form a closely knit surface. These stones are held in place by means of the mechanical interlocking resulting from rolling and by means of the stone dust and chips which are worked in between the larger pieces of stone by means of water and rolling. Eventually this finer material cements the stone together to form the wearing surface. A great many water bound macadam roads fail to give satisfaction because they were insufficiently rolled, and data collected in the construction of about 125 miles of 8-in. water bound macadam road in Illinois show that on limestone macadam there should be 0.04 of an hour of rolling per sq. yd. of finished macadam.

Most of the rolling should be done before any screenings are spread. If screenings are spread before the stone has been thoroughly rolled, they only serve to separate the larger stones. The resulting surface is made up of individual stones set in pockets of screenings and is not as durable as one made of stones firmly locked together by rolling before any screenings are spread. Moreover, if the screenings are rolled dry much the same result will be obtained. The screenings should be washed into the voids in the layer of stone and be allowed to set before much rolling is done on them. After the stone layer has received about all the screenings that can be washed into it and these have set for a day or two, the surface should be finished by rolling and sprinkling.

The durability of the surface will be greatly enhanced if it is covered to a depth of about ¾ in. with a good bonding gravel. Such a gravel should range from ¾ in. down, and should obtain 75 per cent. of hard pebbles, the remainder being sandy loam. The hard pebbles will gradually work in between the stones of the surface and will add materially to the wearing properties. In addition, advantage will be taken of the tendency for colloidal silicates to form under such conditions, thereby effecting a better bond for the surface than could otherwise be obtained.

Development of the bituminous macadam road has been brought about because the wear of the water bound macadam results in a fine dust which is disagreeable alike to the occupants of vehicles using the road, and to those who live along it, and because roads are being used by an increasing number of motor cars which have the well-known effect of blowing away the dust from the road surface and leaving an insufficient amount to fill the interstices between the stone, thereby allowing the stone to become loosened from the surface. Moreover, the thrust of the tire wears the surface rapidly and dislodges any stone not securely bound into the surface.

Inasmuch as the construction of bituminous macadam roads has been brought about to overcome some of the deficiencies of the water bound macadam, it is fair to assume that in the construction of these bituminous macadam roads, all of the good features of the water bound macadam should be retained and these good features be supplemented by the treatment which gives the advantages of the bituminous surface.

The object to be attained in the use of the bituminous surface is to hold the finer material in between the larger stones in the surface of the road so as to prevent loosening of these surface stones and to furnish a coating on the top of the road metal so that the wear on the stones will be reduced to a minimum, thereby eliminating a large part of the dust nuisance. There is nothing in the problem of bituminous construction which would be an argument for a change in the size of the stone or in the general method followed in water bound macadam construction, provided that the results which are desired from the bituminous surfacing can be obtained without such changes. With these principles in mind, the Illinois Highway Commission has been constructing the bituminous macadam by following, with one or two exceptions, exactly the same methods that would be pursued in building a good water bound macadam road up to the point where the bituminous surface is added.

The foundation of the road is prepared as carefully and in exactly the same manner as for a water bound macadam. The crushed stone is placed on the roadbed in layers of a thickness which will permit it to be thoroughly compacted by means of the roller. Usually the roads have been made 8 ins. thick, 5 ins. of which is in the lower course of stone and 3 ins. in the upper course. It has long been the practice among some engineers to bond the lower course of a water bound macadam road, although the practice is not at all general. In the construction of bituminous macadam roads, however, the practice of bonding the lower course has been adopted. The upper course of stone is placed and rolled exactly as if it were the upper course of a water bound macadam, care being taken to key the stone together thoroughly by rolling so that the amount of voids in the surface will be reduced as low as possible and the stones will be well locked together.

If a road is being built of hard stone, such as trap rock or granite, the upper course might be built of smaller sized pieces than is the practice of the Illinois Highway Commission, which is to use the same size as for water bound macadam. But, in any case, it is not believed that bituminous macadam can be constructed by the penetration method successfully if the upper layer consists of pieces much less than those ranging in size from 1 in. to 1½ ins. If hard materials of this class are used, the screenings may be used in the bituminous construction also; the size ranging from ¾ in. to ½ in. being spread before the first spreading of bituminous compound, and the size ranging from ½ in. to ¼ in., free from dust, being used for the final dressing.

If the screenings obtained from the soft limestones are used in the bituminous construction, there will be so much dust present even after repeated screenings that the bituminous application will be seriously affected on account of the presence of dust which will prevent the adhesion and penetration of the binder. Moreover, the small particles of limestone possess such a small wearing value that they are practically worthless in building up a durable surface. For that reason, it is better practice to use two sizes of screened gravel in the bituminous construction, one size commonly known as binder gravel ranging from ¾ in. to ⅜ in., washed and carefully screened, and a size known as torpedo gravel, ranging from ⅜ in. to ¼ in., also carefully washed and screened. The gravel used consists of smooth, round or angular particles, very hard and clean.

After the stone for the upper course of the macadam has been rolled, the surface voids are partially filled with the binder gravel, which is whipped into the surface from shovels, and the entire roadway broomed carefully to work the gravel into the voids and remove the excess from the surface of the stone. The surface of the macadam is then treated with an application of about 1 gal. per sq. yd. of bituminous compound, the binder being spread upon the surface of the road with a special pressure spray apparatus designed by the Commission. This apparatus consists of a furnace tank wagon capable of withstanding an internal

pressure of 100 lbs. per sq. in., equipped with a manhole for filling and a pipe at the rear for discharging. By means of air pressure on the tank the binder is forced out through a metal hose to an "L" shaped pipe nozzle arranged to discharge directly down onto the road surface. The nozzle is equipped with a steam jet which discharges through the orifice through which the bitumen flows. As a result, the binder is blown out in a fine spray and strikes the road surface with considerable force.

Great importance is placed upon the necessity for applying the binder under pressure so as to insure its being forced down into the voids in the surface of the road. At the same time, the spray blows away all dust or other fine material which would prevent adhesion to the stone. After the surface is covered with the binder, the macadam is rolled once over, with the roller wheels wet to prevent sticking. This rolling is simply to replace any stone that may have been disturbed in the course of applying the binder, and, after rolling, the surface is smooth and even for the subsequent treatment. After this rolling, the surface is sprinkled with the ¾-in. to ½-in. gravel, a small quantity only being used and the gravel being worked into the interstices between the stones with brushes, but a slight excess being used so that the pieces will project slightly above the level of the limestone of which the surface is composed.

This second spreading of gravel is again covered with a bituminous compound at the rate of about ½ to ¾ gal. per sq. yd. of surface, and after it is spread, the surface is immediately covered lightly with the torpedo gravel and rolled. The surface is then gone over with the third spreading of the bituminous binder, the quantity used depending upon the condition of the surface and varying considerably with the size and general quality and characteristics of the gravel used, but ordinarily amounting to from ¼ to ½ gal. per sq. yd. of surface. The surface is finally covered with torpedo gravel, rolled and opened to traffic. In the construction of roads in this way a layer of ¼ to ⅜ in. in thickness can be built up on the surface of the stone, this layer consisting of bituminous binder and hard pebbles, making a wearing surface which is of a mastic nature, and contains stone sufficiently hard to withstand a considerable amount of wear.

The action of traffic on such a road is to wedge down the gravel pebbles in between the limestone, forming a crust which is very hard and durable, and at the same time is smooth and affords an excellent foothold for horse-drawn vehicles and a very satisfactory surface for the use of automobile traffic. Usually the most satisfactory texture has been obtained in the surface of the road when the bituminous compound used is of such a nature that it "bleeds" or exudes during hot weather. A road built with such a compound works up into an excellent surface, but some attention must be given to it after the road is opened for traffic, as the "bleeding" will continue for two or three weeks or longer if the weather is hot. This "bleeding," however, causes no inconvenience if the road is kept under observation and covered lightly with gravel from time to time as is necessary.

It is essential in bituminous construction to have access to a laboratory equipped for the examination of bituminous materials if results are to be duplicated, and all materials used should be tested and the results recorded for guidance in future work. Moreover, the construction of bituminous roads requires supervision and workmanship of a high order.

There are many miles of road in the middle western states where of necessity water bound macadam must be built if the roads are to be improved at all in the near future, and there are also many roads that could well be improved with the bituminous macadam and thereby answer all requirements of traffic for many years. Either kind of road must be built with a due regard to a few simple but fundamental and oft-repeated principles which experience has taught are essential to success.

The following discussion then took place on the paper:

President Lewis.—I am glad, gentlemen, to have the author of this paper confirm what I have ventured to intimate in speaking to you at the opening session—that the day of the water bound macadam has not yet passed by any means. I congratulate you upon having had this subject so clearly and effectively presented.

R. A. Meeker (State Highway Engineer of New Jersey).—Mr. President and Gentlemen of the Convention,—I heartily agree with what Mr. Agg so truthfully said in his able paper—that little attempt is being made to observe the simple and well-known principles of macadam construction. While this to a certain extent is true there has arisen a demand for hard roads, and this demand in many cases has been so loud and long that every other quality requisite for a good road has been lost sight of.

It is true that macadam roads are dusty if neglected, but if properly maintained they are no more dusty than many other classes of pavement. Mark what I say—if properly maintained. The great trouble with the majority of road builders and the public at large is that they consider that if a road is once improved, that is the end of it, nothing more is necessary to be done, the road will take care of itself for all time. But the stone wears off, the fine screenings are ground into dust, and the impalpable dust is blown over into the neighboring fields. That is one ground of complaint in New Jersey that possibly is not troubling you people in the middle west. There are farmers and truck raisers who say that this dust depreciates the value of their crops, and particularly that of the smaller fruits. This to them is a serious matter.

If a water bound macadam road is well and properly taken care of and if material that is worn out by traffic is replaced with fresh material and not with dirt, your macadam road will not be objectionably dusty. Many and many a time have we seen a good macadam road covered with mud from the gutters. Of course, our gorge rises to a certain extent; and we get quite an unenviable reputation for kicking; and when they carry that abomination still further and deposit sods and grass upon a stone road words cannot express our feeling. A macadam road in perfect condition should contain not more than 21 per cent. of voids. This is not a guess; it is the result of a number of tests made of the material taken from many macadam roads that have been dug up and carefully analyzed. This density is almost impossible to obtain until after the road has passed through the first winter and spring. Then, if after the frost is out of the ground, the road is well and thoroughly rolled, and all the weak places that develop are strengthened, and the whole surface brought to a regular, uniform grade, the road will wear uniformly and form the best foundation for a future bituminous surface if the growth of traffic warrants the extra cost. This has been proven by years of experience. I would ask you gentlemen who have seen many macadam roads constructed—how many of them have you seen taken care of in the manner I have described? People seem to forget that the most critical period in the life of a stone road is, like that of a human being, during the first year of its life; and if the road is properly started and gets its proper consolidation the first year, it will last and wear until it is practically worn out. The ruts and dust and raveling of which we hear so much will not appear. Seventy per cent. of the roads in our country are off the through lines of travel. These can still be improved with crushed stone or gravel. If the increased travel causes dust to rise in such quantities that it

is objectionable, one or two light applications of a true bitumen will lay it. Possibly I might define a true bitumen as one which contains no lubricating material. If an alleged bitumen contains lubricating material the condition of your road will be like that of the man in scripture out of whom the seven devils were cast.

Mr. Agg's practice of harrowing the stones to secure uniformity in size, while effective for soft limestone, would never do for our harder trap rock and dolomite. We fully agree with his statement that it is necessary to have the surface always made up of fairly uniform pieces and to keep it free from patches of finer material. We find the only way in which we can secure uniform surfaces is by grading the stone carefully before, not after, it is spread upon the subgrade. This method of harrowing is from an economic standpoint, in some sections, a very good thing. But our experience has taught us that it is almost impossible to properly grade the stone after it is placed upon the road. Therefore we insist that our quarrymen shall supply us stone in regularly graded sizes, and if the stone does not come in those properly graded sizes we refuse to accept it. All of our specifications in the State of New Jersey are drawn in that way. Thus, the contractor who signs the contract to build a road under our specifications makes a contract with the quarryman that he shall furnish him with specification stone. That contract is binding upon the quarryman as well as upon the contractor, and if he does not receive properly sized stone he simply refuses to accept them, and the quarryman does not get any money. Just as soon as a quarryman finds that he is working for love he sees a light and makes up his mind to the fact that it is better to do as he agreed to and not as he wishes to.

All that Mr. Agg said about the necessity of thorough wetting and rolling we most heartily indorse. It is impossible to build a good macadam road without the use of plenty of water. In finishing a macadam road we have found no better rule than that of the master road builder, Edward P. North, who said: "Wet your stone until a wave of mud forms in front of your roller." Miles of macadam road in Central Park for years tested the truth of this maxim. What Mr. Agg said about the wastefulness of rolling screenings dry we indorse. It is a point upon which we are very insistent; in fact, so insistent that our specifications expressly prescribe that no screenings shall be rolled dry. A macadam road, whether it is built of limestone, dolomite, trap rock, or granite, must be treated as concrete and to get good results with your concrete you must puddle it thoroughly. To get good results from a crushed stone road the surface must be thoroughly puddled until the water comes to the surface. In the earlier days of our practice we were severely criticized for putting too much water on the roads and making the roads and shoulders muddy. Afterwards when the road was finished nothing was said about it.

I notice a great many practical road builders here, and they will all agree with me that if you do a good job you hear nothing about it, but if you make one slip, what you hear is aplenty.

We have listened to many able papers upon the more expensive types of pavement. It has been our endeavor to avoid mention of these as far as possible, confining our remarks to those road coverings that can be most cheaply laid. Each section of the country has material at hand which may be used with great benefit upon its highways. Commissioner MacDonald puts a light coat of stone chips upon his gravel roads and obtains a very good road. We have also used this method with very satisfactory results. If the road builder in each section of the country carefully tests the materials he has at hand, he will find something that if properly applied will greatly improve the surface of his roads—crushed stone in a rocky region, gravel in another, and a mixture of sand and clay in another, till at last we reach the alluvial flats where the paving is done with burnt clay as demonstrated by the Office of Public Roads, and what was alleged to be impossible in road improvement is accomplished.

In New Jersey we have a greater variety of soils and rocks than have many of the other states. Commencing with the older rocks of the northern portion of the state, we run down the scale until we reach the sand and alluvial plains near our southern limits. Therefore, our experience is possibly more varied than that of many others. We found that the old assertion that trap rock is the best stone which can be used for a macadam road is subject to qualifications. On heavily travelled roads trap rock is the ideal stone for water bound macadam. In roads of medium or lighter traffic, we find that a dolomite, or one of the harder limestones gives far more satisfactory results, is less costly to prepare, and at the same time forms a harder and smoother surface. Hence we must not take the maxims laid down in the books without a grain of salt. You will find possibly, in your own section, material that will improve your highways to a wonderful degree. Proper location, proper grading, proper drainage, and proper construction, will always yield very good results.

We hear a great deal about the waste of money spent in improving roads. It is said: "What is the use, why should we issue bonds for the roads when they wear out in ten years and that which has cost so much will all be gone?" In our state we have built some roads that have cost us $50,000 a mile, but over $40,000 of that was for relocation and grading. Now, that did not wear out. That was not dissipated, but is a valuable asset. When you consider that a 10 per cent. grade requires the expenditure of as much power to traverse one mile of it as would be expended in travelling 6.3 miles on a level, you begin to realize the advantages to be derived from reducing the grades. In the old days they told us that it was a waste of money to grade, and on the old road surfaces this was to a certain extent true, because any load that you could haul through the muck and mud of the flat you could haul up the hard stone hills. Now, those conditions are changed. Upon a uniformly smooth surface it is possible for a team to haul from four to six times as much on the level as it could possibly haul up the same old hills; and if we are to derive the full value from our improved roads proper grading must be given the attention which is its due.

President Lewis.—Gentlemen, this subject is open for discussion from the floor. We will be glad to hear from anyone, and I know that the author of this paper will be glad to answer questions.

F. F. Rogers (Deputy State Highway Commissioner of Michigan).—I would like to ask Mr. Agg about how much he has found the increased cost of bituminous over the plain water bound macadam, also what kind of materials he used this year, and if they have proven satisfactory?

Mr. Agg.—I will answer your first question and say that the difference in cost between the water bound macadam and bituminous macadam in the Illinois work has been about 18 cents. per sq. yd. Now, as to the repairs, the commission has been conducting experiments on sections of roads throughout the state upon which they have been using some of practically every bituminous material which is on the market in Illinois; and it would be impossible to go into the results of all those experiments this afternoon. The commission will shortly publish a report in which will be given the results of three years of experimentation with bituminous

compounds which have been used with about 20 or 30 different materials. If any of you would care to get that report and will write to the Illinois Highway Commission, Springfield, Illinois, I will be glad to see that you get a copy. In general I would say, however, that we have found that on the roads which are subject to a covering of sticky mud, pulling in from the side roads, which is a condition that is found in most of our roads, we found the various kinds of tar binders to be unsatisfactory. On the other hand, we have used on some roads which are not subjected to this action, tar binders which have given excellent results. We have also found binders which could be used on a road in a soil of an acid nature, the kind of soil we have in southern Illinois, and the same binder used on roads in the northern part of the state where the soil is alkaline or neutral, went to pieces very shortly. As I have said, we have an extensive series of experiments going through our laboratory, the results of which will be given later.

Mr. Rogers.—Just one other question as to the comparative results of hand pouring and pressure spraying?

Mr. Agg.—We used the hand pouring method for two years and then followed that by two years of the pressure method. It seems apparent to us that you cannot hope for satisfactory results in bituminous work by the hand pouring method. Occasionally a good road is constructed in that manner, but, in general, in our work we have found that about one road out of four constructed by the hand pouring method has proved satisfactory. This is due to the fact that inevitably the bituminous binder will be thicker in some places than it will be in others. When the road is put under traffic, this condition is not apparent, but as the road gradually wears, the traffic gradually compacts the surface, then the places where the binder is thick are seen as raised places in the road. The places between these high places being lower, the action of traffic is to increase this effect as time goes on. Some roads that were constructed by the hand pouring method three years ago had to be entirely resurfaced because the surface became irregular. The texture was all that could have been asked, but it was in this condition due to the effect of the binder put on in that way. We do not think that bituminous macadam can be put down by the hand pouring method. (Applause.)

John S. Gillespie (Road Commissioner, Allegheny County (Penn.) Road Department).—Mr. Chairman and Gentlemen: I am taking issue with Mr. Agg and our distinguished chairman in regard to the macadam road. It is something like a prescription. A prescription may cure one when it will not cure another. Macadam roads may be successful in some places, and not in others.

I have charge of the roads of Allegheny County, Penn., and some of you gentlemen have pamphlets showing what Allegheny County has done for good roads. We have at the present time in our county, 450 miles of improved roads. A year ago we had 360 miles of macadam, yet at the present time we have only 308. The reason for this is, up until September, we had about 60 miles of macadam road and we made the same into asphalt roads. Macadam roads are not a success, and have never been since the automobile came into existence. It may not make a difference in the East where Mr. Meeker is—I have been over a great many of his roads—they have the hard trap rock. We, in Allegheny County have the limestone, and most of that is shipped in from Ohio.

I am going to give you the specifications of our roads; and I don't think there is a macadam road built anywhere in the United States that is better built than we are building. Our macadam roads are built with 8 ins. of telford stone, thoroughly rolled and napped, and then we have the macadam top of 4 ins., giving us a 12-in. road. And yet they are not successful.

In regard to the dust, the limestone dust; we have that. We take care of that problem. I am not the father of good roads in Allegheny County, but I have been the mother of good roads for seven years; I have been taking care of them. We do all our own repair work. We have 14 road rollers and we have 14 gangs that are going all the time. Two years ago this summer I had charge of putting on 96,000 tons of stone in resurfacing our roads. We spend $1,500,000 a year on roads. You will notice by the pamphlet our valuation is high, the same amounting to $1,141,567,110, and there isn't much trouble for us to get money. We have plenty, and we can try anything that we want to that looks good. We have used oil. Five years ago this summer I came down to Cincinnati in company with our county commissioners. We went to Lexington and looked over their oiled roads. Last year we used 422,000 gals. of oil. We have not used less than 300,000 gals. of oil per year for the last five years. Now, I just tell you that to show you that we care for our roads. Not only that, but we have a patrol system in Allegheny County. We always have had it, ever since the first road was built. At the present time we have 110 caretakers. Each caretaker has between 3 and 4 miles of road to take care of. These men are hired by the year; they work every day, and are paid $55 a month. Their duty is to go along and keep the ditches and sewers open, and keep the weeds cut down. As you all know, weeds grow rapidly along a macadam road, especially a limestone road, because limestone is a great fertilizer.

Our experience is that macadam roads are no good. They are a good substitute. As Mr. Agg says, you have to fall back on the macadam. That is all right, but if you if you have the money you don't want to fall back on macadam. Now, some of you gentlemen have been to Allegheny County and seen our roads, and know that we have built them right, yet they do not stand.

In regard to putting down the macadam road, from practical experience this is what I found: The contractors do not build the roads, or put down macadam roads as we do, because it takes a little more time. I am going to tell you now how we bond our roads so that you will know whether or not we do it right. In putting our roads down we do much the same as the gentleman from Illinois; we put our stone down and thoroughly compact that. I found from experience that by using the larger stones we got the best results. You can go along a road and reach down, blindfolded, and pick up all the stone you can hold in your hand; probably there will be three or four pieces, and by pressing them together they will interlock, and that is why the larger stone is used. That is how the Romans built their roads, with the larger stones and of a uniform size. We roll that thoroughly, and I have taken 60 bushels of coal across the road just after the rolling and before any screenings were applied, and hardly made any impression on it. We roll the ballast well, and then we put on a slight sprinkling of screenings, and by the roller passing over the same two or three times it shakes the screenings down between the stone. Then we apply the water, thereby getting the road to bond from the bottom. We put on only a light coat of screenings, "feeding" it, as I say to the men, in order to get the proper bond. We then roll the same until we have a batter all over the road. We leave this then, and take the roller on to a new piece of 40 or 50 ft. Too much screenings has a tendency to "choke," giving you the necessary batter, but not the bond.

I might say that I have always found in putting down a macadam road that it is best not to take too long a stretch,

because one of the most important points in building a road is the water. If your roller covers too great a distance, you do not get all the benefit of same as by the time the roller goes over the road a second time, the water has soaked into the foundation. I find you have to seesaw quickly to get the advantage of same. You must get the benefit of it before it enters the road.

In starting the new piece, the same methods are applied which I have just given. In a day or two the sun bleaches the road, causing white spots to appear. We then take the roller back and roll the same thoroughly. We then take the roller off and flush the macadam surface well with water, and we leave it. That flushing cements the road tight, and the result is, in a day or two we have a road with a hard, metallic ring. Now, that is the way we put our macadam roads down, so you can be the judges as to whether or not we put the same down right. I condemn it. A macadam road in certain seasons of the year, or certain winters, is better than others. In Allegheny County three years ago this winter, the independent ice companies did not get a single pound of ice. It would freeze a little at night, and thaw out in the morning.

Seven years ago, when I took charge of the roads in Allegheny County, I was conceited enough to think I knew a little about roads. Things I advocated then, I condemn now. Then the macadam road was good, but we have a different traffic to-day. The automobile has come in and it has come to stay. Even those who say macadam roads are good, find fault and say they can't take care of the automobile.

As I was going to say, where you have an open winter, the frost goes into the macadam, and in leaving the same in the spring it disturbs the bond, making the road "green." During this period you can watch a heavily loaded wagon go along and rut your road. Now, if you could only close your road in the spring when the frost is coming out, could close it entirely to traffic, the elements would rebond it, but we can't close them and the roads get rutted. Now, gentlemen, that is my experience and my belief is that the macadam road is no good. I don't say they are no good everywhere, but they are no good in our county, nor in the western part of Pennsylvania. We can't get trap rock. A gentleman here at this convention told me that he could sell us trap rock, f.o.b. the boats at Cleveland for $1.50 to $1.60 per ton. Now, if we are to pay that price at Cleveland, together with the freight to the Pittsburg district, making a total of $2.25 to $2.50 per ton, it will be cheaper for us to adopt the mechanical mix or penetration. That is what we are doing. This summer we put down 17 miles of penetration and about 30 miles of the mechanical mix.

We have all kinds of roads in Allegheny County, we have the macadam road, brick road, rock asphalt, Warrenite and Amiesite, and we have all kinds of resurfacing work. The telford foundation of the first road constructed in our county is still there, we never lose the foundation and the second time a road is covered it is better than the first, even with macadam.

Will P. Blair (Secretary, National Paving Brick Manufacturers' Association).—There is just one suggestion that I want to make. It may not reach the point, but the last speaker has just stated that the greatest trouble they have with their macadam roads in Allegheny County is the fact that in the spring of the year and during light winters, where they are having constant freezing and thawing, the road gets into such a condition that it is easily rutted. Now, if the gentleman will permit what may seem to be a criticism of the way in which they build their roads, and leave their roads in that county, it will be given in the best of spirit, and I believe it may be of some assistance to them, and to all road builders. The condition of a great many roads in Allegheny County is this: The water is not carried from underneath the bed of the road to the ditches on the side of the road. That is the condition of a good many macadam roads in this country in the winter and spring. And that is the trouble with all kinds of roads unless you carry off the water or the moisture and let the air in, not by building a ditch along the side of the road, not by conveying the water from certain stream watering places on the road, where the water oozes out under the road, etc., not by carrying that down the middle of the road and into the side ditches, but by putting in cross tiling at right angles, across the roadbed, and getting that moisture immediately out and keeping your roadbed dry. If you keep your roadbed dry underneath, your moisture, or your temperature—your low temperature—is not going to disturb the aggregates and the condition of the road as found in the summer time. Keep it dry, and it is going to keep in place. That is just a suggestion.

Mr. Gillespie.—Just a minute, please, in answer to Mr. Blair. Gentlemen, I said that the first road built is still as good as ever; and that was built in 1897, showing that it isn't the foundation. We put French drains in every 50 ft. during the construction of our roads. I say that when our roads are resurfaced they are better than when first built. It is not the foundation that gives way, it is the top coat that blows away, the telford remains. The matter of drainage is well taken care of by the frequent use of these French drains.

COMBINED STEEL OUTPUT.

The combined output of steel in the United Kingdom, Germany and the United States in 1911 exceeded 45 million tons, whilst the world's output is estimated at between 59 and 60 million tons. A comparison of the approximate outputs of the chief producing countries shows that the United States produced in 1911, 23,676,000 tons, Germany 14,778,000 tons and the United Kingdom 6,565,000 tons. A noteworthy feature of the returns is the increase of about 24 per cent. in Germany's steel output, whereas that of the United Kingdom and the United States remains practically stationary.

POWER PRODUCTION COSTS.*

Cheaper generation in the near future is dependent on more efficient turbine plant, and the recovery of by-products from coal by the employment of gas fuel for firing boilers. The companies whose business is general supply, as contrasted with the special purpose power stations, might be expected to take fuller advantage of such tendencies. But in any case the margin for saving in costs of production must be substantial. When it is observed that a municipal plant such as that installed at Stockport, consisting entirely of reciprocating engines, can gain merited approbation for working costs of 0.56d. per unit on a load factor of 23.42 per cent.—a result as favorable as that achieved by Manchester, generating nearly twenty times the quantity and employing large turbines—it is clear that there is a large field for profitable study in this department. By the improved load factor resulting from more general and diversified demand numerous items of expenditnre can be reduced in proportion to output while the coal costs may almost disappear when the full by-product value is realized.

*From Supplement to London Times.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **60** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, MARCH 6, 1913. No. 10.

CONTENTS OF THIS ISSUE.

The article on Storm Water Discharge, by R. O. Wynne-Roberts and T. Brockmann, will be concluded in next week's issue, March 13th.

FORESTRY AND IRRIGATION.

A great number of people do not realize to what extent the present efforts towards development of scientific and practical forestry will ultimately benefit irrigation. The extent to which it will simplify the work of engineers in the economic handling of water is often not understood. These benefits apply more particularly to our timbered provinces, but, in so far as most of the rivers of the prairie provinces have their sources in the forest lands, it applies to them, though not to the same extent, as well. British Columbia, however, on account of its topography and the great possibilities of irrigation in that country, ought to be more vitally interested than the other provinces in the proper understanding and practical working out of the relation of forestry to the making productive of its many large tracts of fertile land.

The aggregate of water power available in British Columbia is tremendous, and the province is only in its infancy as far as development and using that water for man's benefit goes. The greatest difficulty with northern mountainous countries re water courses is the variable flow of water. Summer's sun, even when there is no rain, produces such a melting of snow on the mountain tops, that the rivers are, many of them, in flood or high-water mark in August. In the same way, cold in winter reduces many streams to practically nil. This variation results in many a fine summer's waterfall being out of consideration, commercially, for power development purposes, but it is not so serious a drawback for irrigation purposes. Irrigation is only needed in the summer, and if a country can utilize its gushing summer streams for an increase of the productiveness of the land, the better are the people and the province. It is in the lessening of difficulties and expense for irrigation that forestry holds out promise to the people and engineers. Forests, as we all know, act as a protection to moist earth by keeping off the sun's rays. We have seen, for example, snow in our woods long after it has disappeared from the open places. The forests are partially a storage basin for the winter's moisture or for sudden rains. Strip British Columbia's hills of the forests and it would only aggravate the variable high and low water levels of its rivers, and there is a consequent increase in the costs when trying to properly control and distribute such water. Not only this, but the sun, after the forests are cleared and fires taken place, often bakes the surface hard, and rainfalls gathering on the surface rush down, scouring and gouging out earth in deep channels, and may possibly, by depositing unfertile mountain soil on lower productive lands, finally destroy the fertility of the good land itself. In short, clearing a mountain hillside bare of trees may just mean to the land below that, whereas formerly irrigation and fertile acres were possible, yet afterwards, thanks to the extra expense involved in controlling and suitably distributing the water under the new conditions, the whole plan becomes as a commercial proposition impossible.

This is not likely to happen often, but even if it does not make irrigation impossible, yet as a general rule one can state: "The more unconstant the feed of waters to lower levels due to mountains cleared of trees (either by lumbering or fire), the more increased the cost of handling that water for irrigation." Whether the irrigation is in the form of government work paid for by taxes or by rent to a water company, the people pay, and in the absolute destruction of forests the country is not only poorer by the loss of lumber, but indirectly by the added cost of land fertility.

British Columbia has not been asleep in its attention to its water rights and powers. Its Water Act of 1909 re irrigation was an improvement and an advance on all

the laws of this continent. California was trying, and has possibly passed by now, legislation modelled after certain provisions in the Water Act of British Columbia. Canadians can take pride in seeing the leading irrigated state in the United States willing to learn off a province in its infancy as regards irrigation. Let us hope British Columbia meets with a fitting reward in the way of good results and prosperous people.

TWO GOVERNMENT INVESTIGATIONS

The United Shoe Machinery Company has had the doubtful pleasure of being investigated as an alleged combine by the governments both of Canada and of the United States. While nominally the companies are distinct, in reality the Canadian concern is a subsidiary of the Boston firm.

The matter received additional interest in view of the recent decision of the Supreme Court at Washington, which held, in effect, according to a despatch from that city, that the Sherman anti-trust law does not forbid the mere combining of non-competitors in an industry. The company was held to be a legal concern.

In Canada, two of the investigating boards concluded that the United Shoe Machinery Company of Canada was a combine. They reported on October 18th, 1912, their conclusions as follows:—

"Such advantages as are claimed by the company for its system of doing business, when they are not inconsistent with the existence of competition, are not vital to a consideration of whether competition is unduly restricted; neither are any complaints made by the manufacturers where the ground of these complaints would disappear if the way were open to competition.

"Eliminating from consideration all those elements of the relations between the company and its customers, we find that:—

"The United Shoe Machinery Company of Canada is a combine, and by the operation of the clauses of the leases, quoted in the foregoing, which restrict the use of the leased machines in the way therein set forth, competition in the manufacture, production, purchase, sale and supply of shoe machinery in Canada has been and is unduly restricted and prevented.

The representative of the company on the investigating board signed a minority report, stating that, while the facts established by the evidence submitted to the board were set out in the majority report, he differed with the other members of the board with the conclusions that were drawn from those facts. He thought that, considering the company's methods as a whole, they were not against public policy. The company, he added, had been of manifest advantage to the manufacturer of boots and shoes, to the labor operating the machines, and to the consumer.

Discussing the case against the United States company, District Attorney French, who had charge of the government case against the corporation, is reported as saying:—

"The question which has just been decided by the Supreme Court was merely one of criminal pleading. The great and important issue between the people of the United States and the United Shoe Machinery Company is whether or not the latter is a monopoly in violation of the Sherman act, and this depends largely, if not wholly, upon the view which the courts will ultimately take regarding the tying clauses in the leases, or, generally speaking, of the patent question involved. Upon these matters the court expressly declines to pass, apparently for the reason that they were not presented by the record, and says in effect that it must accept without question the interpretation of the lower court, which regarded the indictment as merely referring to the organization of the company, not to the 'tying clause' leases."

The strongest feature of the United States Government's effort to show an unlawful combination in restraint of trade, says Solicitor-General Bullitt for the Government, was the "tying" clause of the agreements, by which it is alleged that the company sought to compel shoe manufacturers to buy machines from it and none other. That question, he declared, was not considered by the court, because the lower court had interpreted the indictments involved in the latest decision as referring solely to the organization of the United Shoe Machinery Company.

The tying clauses were largely the bone of contention in the Canadian case. Mr. Winslow, president of the company, admitted in the Canadian investigation that the purpose of the tying clauses was to give the company that security by preventing the introduction of other machinery into the factory. He stated that if the company were obliged to remove the tying clauses from its leases a change in its system of doing business would be necessary. He was not able to state the basis on which the rates of royalty were calculated, these having been continued from the previous leases. He assigned no reason for the necessity of a change, nor did he indicate what that change would be.

No other evidence was adduced by the company to show what would be the nature of the changes to be made in its system if the tying clauses were eliminated, nor that changes would be necessary for the protection of its interests.

"As indicating that the object of the tying clauses," said the Canadian majority report, "is rather to prevent the introduction of competing machinery than to establish continuity of operation, it may be noted that the company's welter and stitcher will be leased to work in connection with other principal machines obtained from outside sources, that machines corresponding to the machines of the company's general department can be obtained from outside and introduced into the service, and that the company will sell the machines of the general department, in which event the company has not the same interest in keeping the machines in order as exists when machines are leased."

The Canadian investigators found the company to be a combine, and, as the six months' delay recommended and adopted, dates from October 18th, 1912, the company is liable to a penalty not exceeding $1,000 and costs for each day, after April 18th, 1913, during which the company continues to offend. The court procedure in Canada seems to have been far more simple than in the United States, where the government has not yet fired its final shot in the case.

EDITORIAL COMMENT.

We are pleased to be able to give in this week's issue a further summary of the discussion which took place at the recent annual meeting of the Canadian Society of Civil Engineers, held in Montreal, January 28th to 30th. It was impossible to cover this discussion fully in the limited amount of space at our disposal in the daily edition of *The Canadian Engineer*, which was issued in connection with that meeting. We are glad, however, that we have this opportunity of giving it now, and it will, no doubt, be read with a good deal of interest by not only the delegates who were in attendance at the convention, but by many other members of the society who were not able to be there.

THE MOOSE JAW WATER SUPPLY.

By P. Gillespie, B.A.Sc., A.M.Can.Soc.C.E.*

That portion of Alberta and Saskatchewan between the 54th parallel of latitude and the International Boundary comprises nearly 250,000 square miles. It is drained by the Saskatchewan and Assiniboine Rivers and contains not a single body of water as large even as Lake Simcoe. On a basis of only 20 persons to the square mile, this region would become the abode of five millions of people. The present population is something in excess of 800,000.

When we consider that the great centres of population in Europe—St. Petersburg, Christiania, London, Paris and Berlin—lie north of the 49th parallel of latitude, that the great migrations of history have been westward and northward, that Canada is the last great area awaiting the enterprise and energy of the pioneer, that while in point of population the United States of America stood 100 years ago where Canada stands to-day, her railway mileage was not until 1857 equal to that of the Canada of to-day, nor her foreign trade as great as that of this country at the present time until the year 1861, it will, I believe, be granted that the growth I anticipate is a very moderate one indeed, and that the problems consequent theron are really only beginning. One of these is that of water supply.

To the life-long resident of Ontario, with its fine series of inland and border streams and its magnificent chain of great lakes, this special problem of the western plains will scarcely appeal. In the prairie provinces, as indicated above, the scarcity of streams or lakes capable of serving large communities has rendered it both acute and unique.

The city of Moose Jaw, Sask., is situated on the main line of the Canadian Pacific Railway, some 420 miles west of Winnipeg, and 40 miles west of Regina, the provincial capital. In the language of the surveyor, it lies in Township 16, Range XXVI., West of the Third Meridian. Its present population is approximately 25,000, probably half of whom are dependent directly or indirectly upon railway operation and maintenance for a living. It is surrounded by an excellent agricultural district, and of late years has experienced a period of growth and prosperity which would be regarded as phenomenal in older districts. In consequence, it has outgrown many of its public services, including its water supply. Up to a few weeks ago this was obtained partly from a well in the city near the confluence of Thunder Creek and Moose Jaw Creek, which is fed by an infiltration gallery receiving water percolating from the creeks through the soil; and partly from Snowdy Springs, so-called, seven miles distant in a southwesterly direction, the supply flowing by gravity through a ten-inch wooden main. Two years ago a deep well was bored at a point adjacent to the present city power house in the hope of locating natural gas. On reaching a depth of some 1,200 feet the drilling was temporarily abandoned, a heavy flow of water having been encountered. This water is saline and by itself not potable. In cases of fire it was the custom to pump raw creek water and gas-well water into the distributing system, the subsequent draining of which by hand having been relied upon to free the mains from water unfit for domestic use. Of late years the supply has proved quite inadequate to the needs of the citizens, so much so, in fact, that at times water was available in the service pipes for an hour only three times a day.

In the spring of 1911 Mr. Walter J. Francis, C.E., of Montreal, was asked by the municipality of Moose Jaw to investigate the entire situation and advise as to a water supply from this western city. Mr. Francis began his investigation early in May. This involved a study of some ten suggested courses, most of which were found to be impossible because of one or more of three reasons, viz., insufficient quantity, unsatisfactory quality or prohibitive cost. Among the sources investigated were the Moose Jaw Creek, Last Mountain Lake, the Snowdy Springs, the South Saskatchewan River and Sandy Creek, all well-known to residents of Southern Saskatchewan. For the reasons indicated above, all were rejected for immediate development, save the last-mentioned—Sandy Creek—a stream near Caron, some 20 miles west of the city along the main line of the Canadian Pacific Railway.

Mr. Francis' report, in brief, suggested that the city proceed at once to concerve its then present supply by installing a separate high-pressure fire system in the business district. This would enable the city to cease using the limited domestic supply for such purposes as street watering, most manufacturing processes and fire-fighting. The city was also advised to proceed at once to make a thorough exploration of the valley of the Sandy Creek. The indications at the time the report was prepared were that there was available there one million gallons of water per day. If this, by subsequent investigation, should be confirmed, it would mean that this quantity, together with the supply at that time serving the city, would be sufficient for a city of 30,000 people. The ultimate source, it was obvious, must be the Saskatchewan River in event of the population very much exceeding the limit indicated. Moreover, if the Sandy Creek project were to be developed, much of the necessary installation would become a part of the Saskatchewan development, since both sources lie in the same direction from Moose Jaw. The expense involved in utilizing the Saskatchewan necessarily placed it beyond the immediate reach of any single municipality as far distant as Moose Jaw, but a suggestion was made that the city combine with other interests and prepare at once for the use of the Saskatchewan River water at a time not far in the future.

The city council of Moose Jaw, with characteristic western enterprise, immediately voted an appropriation for the investigation of Sandy Creek, which investigation was conducted during the summer months of 1911. Weirs were installed in eight different places on the creek, from which daily readings covering several months were obtained. A number of deep test wells were drilled in various places across the wide valley of the creek, revealing the presence of a lower supply of water (apparently separated from the upper by an impervious stratum of clay) whose analyses were markedly different from those of the surface water. The knowledge acquired during the exploration tended to confirm the earlier opinion as to quality and quantity, and Mr. Francis' firm, Walter J. Francis & Company, were authorized to proceed with the preparation of final plans and specifications and the supervision of the work. The contracts for the work were awarded during the early months of 1912 and construction was actually begun in April of that year. The water was in use in Moose Jaw before the end of November or within eight months.

The works consist of an infiltration or collecting gallery terminating in a main well over which is constructed a headworks pumping station, a pressure main, a headworks reservoir of 500,000 gallons capacity, a gravity main 96,200 feet long extending from Caron to Moose Jaw, a storage reservoir (in the city) of 2,000,000 gallons capacity, a second pumping station and an elevated tank.

The Infiltration Gallery.—The infiltration gallery will consist, when complete, of 4,000 lineal feet of 20-inch glazed tile, laid with semi-open joints in the water-bearing sand of the valley of Sandy Creek, at a depth of about 16 feet. Manholes are provided every 800 feet, or wherever changes in

---

*Associate Professor of Applied Mechanics, University of Toronto.

direction occur. The invert of the pipe has a gradient of 0.4 per cent., and is approximately parallel with the natural surface of the ground in which it lies. The lower semi-circumference of each joint is sealed with a cotton sack filled with what was originally dry cement and sand. This is carefully placed in the invert of the bell when the pipe is laid. This sack adapts itself to the irregularities of the tile while still soft, and later on prevents the admission of sand to the pipe. The upper half of the joint is protected by a depth of one foot of graded gravel which, for the sake of economy, is confined in a cheaply constructed box of spruce lumber scribed to the curvature of the tile. This also prevents the entrance of sand into the interior of the pipe. It will be seen from this that the gallery is intended to drain the surface stream and that it may lower the level of the ground water down to, but not below, the axis of the pipe.

with was the prevention of water coming into the trench from underneath the piling, especially where the line led across lagoons, as it did in a portion of the work.

The infiltration gallery terminates at its lower extremity in a main well circular in plan, 15 feet in diameter and 29 feet deep, and constructed of concrete. An adjunct of this well is a valve chamber through which the water passes on its way to the well and admission to which from the gallery is controlled by a 16-inch gate valve operated from the floor above. This valve chamber is provided with a permanent metal weir enabling the operator at any time to determine the quantity of water being received from the gallery. The excavation for this well was done entirely by the dredging pump. Over the well stands the headworks pumping station.

Headworks Pumping Station.—The headworks pumping station is a brick structure, 48 x 36 feet in plan with concrete foundations, base, floor and roof. The mechanical equipment includes two Fairbanks-Morse two-

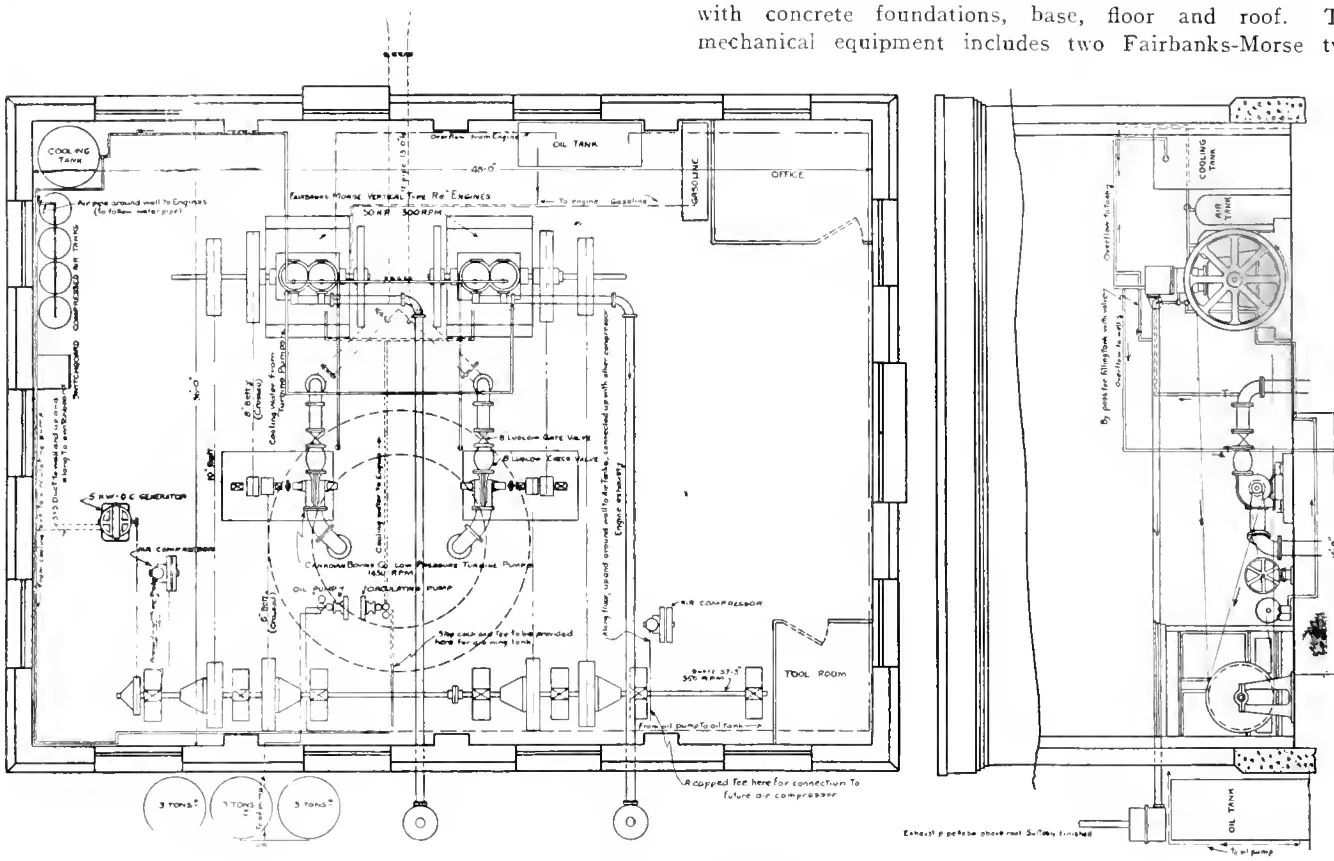


Fig. 1.—Headworks Pumping Station.

The laying of this gallery in a water-bearing gravel and quicksand presented some special difficulties. Two parallel rows of 9-inch United States Steel Company's interlocking steel sheet piling 18 feet long were driven one on either side of the proposed centre-line of the gallery and distant therefrom two feet. This was accomplished without special trouble with the aid of a 2¼-inch McKiernan-Terry pile hammer fitted with special driving cap, and by a liberal use of the water jet. The first six feet of depth of excavation was done by hand, after which a 6-inch Goulds centrifugal dredging pump was put into service and the remainder of the excavation done thereby, sufficient water to render this operation possible being meanwhile admitted to the pit from the creek above. Bulkheads and transverse shoring were placed as the work progressed. The pulling of the piles was accomplished by the aid of a Yale & Towne 3-ton triplex chain block for starting and an ordinary pair of triple blocks with a 1-inch fall and a steady team of horses for the rest of the operation. A generous application of axle grease to both bulb and channel sides of the pile during the driving greatly aided the pulling afterwards. The greatest difficulty met

cylinder, four-cycle, 50 h.p. vertical oil engines, belted through a line shaft to two Böving centrifugal pumps, each of 600 gallons per minute capacity. The arrangement is such that either or both pumps may be operated by either engine. The nominal speed of the engines is 300 r.p.m., and that of the pumps 1,450 r.p.m. The two discharge pipes join with the 18-inch pressure main in a special wye outside of and below the pumphouse wall. Each pump is protected by a check valve set in the discharge main and priming, when necessary, is done by a by-pass connecting the pressure main beyond this valve with the pump casing. In addition to the engines and pumps there is a 5 kw. generator for lighting purposes, an air compressor and air storage tanks for starting, and oil and water pumps for fuel and cooling respectively. Ultimately, when it is decided to install the deep wells for the purpose of obtaining the water in the low-lying strata of gravel, an air-lift equipment will be employed and the compressor capacity will be increased. Provision for such increase has been made in the lay-out of the station. The usual storage tanks for oil, gasoline and water are provided and complete the equipment.

The Pressure Main.—As stated elsewhere, the pressure main has a diameter of 18 inches. It consists of welded steel tubes of thickness ¼ inch and of average length 17 feet. The ends are plain and the joints are made by the Custer method. A sketch of this joint is shown herewith in Fig. 2. The joint mechanism consists of a collar sufficiently large in diameter to slip over the ends to be connected, two followers or gland rings, two rubber gaskets and ten track bolts. The collar is ten inches long and on its interior are two projecting buttons which insure half the collar covering each of the two ends to be connected. A special Custer wrench is used for tightening the bolts. The advantages of this joint are that it is slightly flexible after being laid, that it can be made under water, and that a change in direction equal to three degrees at each connection can be secured with 18-inch pipe. With 10-foot lengths it will be seen that a thirty-degree curve could be followed if necessary. Experience has shown that if proper care be taken in the jointing. Absolute watertightness can be secured. The specification for laying required that as soon as the pipe was connected up, backfilling to a depth of one foot over the pipe, carefully rammed, should be done. The objects of this were to avoid injury to the pipe in case of caving-in, and to prevent the pipe floating in wet situations where water could not enter the free or open ends of the pipe. Part of this pipe had to be laid at a depth of 14 feet and over, owing to the irregular nature of the ground through which it passed, and the advisability of avoiding summits in the profile of the pipe.

Headworks Reservoir.—The headworks reservoir is an all-concrete structure circular in plan, 75 feet in diameter and holding, when full, 17 feet of water. The roof, which is of the girderless type, is supported by 9 columns placed in three rows of three each. Admission of water to the reservoir and discharge therefrom are controlled by 18-inch gate valves. The admission valve is protected by an 18-inch check valve. The roof is about 8 feet above the normal level of the ground. Backfilling against the exterior walls and over the roof slab adequately protects against frost. The concrete was the equivalent of a 1:2:4 mixture thoroughly well mixed and carefully tamped. No other waterproofing precaution was employed and when, after construction, the the reservoir was tested full for 24 hours a leakage of less than ¼ of 1 per cent. occurred. The difference in level between the normal water level in this reservoir and that of the storage reservoir at Moose Jaw is 57 feet. The infiltration gallery, headworks pumping station, pressure main, and headworks reservoir were done by day labor instead of by contract, it having been felt that the many uncertainties to be anticipated rendered this procedure advisable.

The Gravity Main.—The gravity main from the headworks or Caron reservoir to the city is of 18-inch welded steel with Custer joints of the type already described. The invert is laid at an average depth of 9 feet. To facilitate examination and repairs, it is divided by gate valves into sections averaging one mile and two-thirds in length. The entire pipe is laid on either a rising or a falling gradient, the objects being to permit entrapped air to rise to the summits where air valves are provided. At each air valve there is provided also a poppet inlet valve for the purpose of admitting air whenever a section of the line is drained. Six-inch drains are provided at all depressions and are controlled by six-inch gate valves. These will permit the main to be unwatered in sections when necessary.

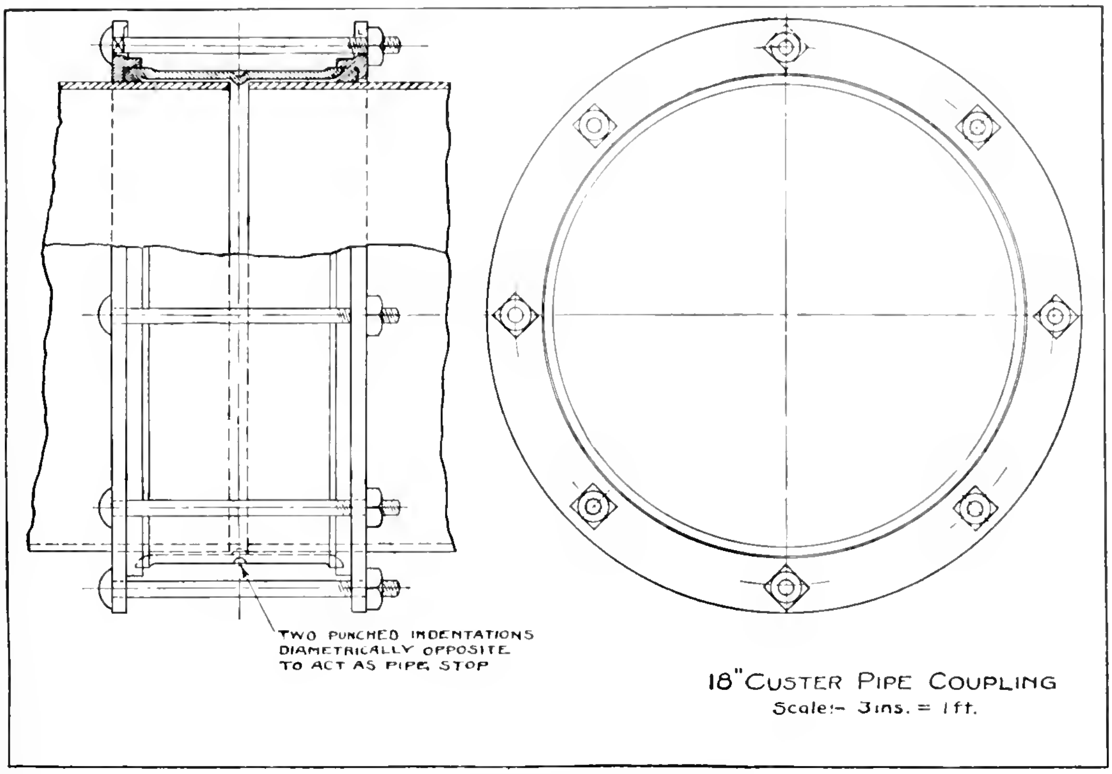


Fig. 2.—Custer Pipe Coupling.

Storage Reservoir.—The storage reservoir at Moose Jaw has a capacity of 2,000,000 gallons. It is rectangular in plan and is divided transversely by a partition into two equal parts. The 18-inch gravity supply main from Caron divides at a point exterior to the wall and an inlet branch goes to each half. Each branch is equipped with a Mason, float-operated, balanced valve, which controls the admission of water. Except at such times as the demand of the city services exceeds the capacity of the gravity supply, this arrangement will insure a full reservoir always. The reservoir is of reinforced concrete throughout, the floor having a thickness of 10 inches. The exterior walls consist of panels 18 feet high spanning between counterforts spaced 9 feet on centres. The partition wall is similarly constructed, except that it is designed to resist a full head of water in either direction. The roof is of the girderless type, supported on columns spaced 18 feet both ways, the slab proper having a thickness of 7½ inches. A five-ply felt and gravel covering overlies the concrete roof, and on this, in turn, a filling of two feet of earth is placed.

The Moose Jaw Pumping Station.—The Moose Jaw pumping station is of the same general style of construction as the headworks pumping station. Its equipment consists of two Canadian Böving centrifugal pumps direct connected

to two Siemens 35 h.p. motors which receive their power from the supply mains from the city's central power station. These pumps lift the water to the elevated tank, a height of upwards of 110 feet. They will ordinarily draw from the storage reservoir, but the piping arrangements will permit water to be drawn direct from the Caron gravity main. In addition to this, either pump can draw from either side of the reservoir. Finally the piping system will permit of water being fed (without pumping) from the reservoir or from the gravity main into the city's distributing system, either of which would give a moderate pressure over all of the city except the highest parts. If desired, the elevated tank may be cut out and the pumps made to discharge direct into the mains. The motors are equipped with Cutler-Hammer switches operated by a float in the elevated tank. This is intended to keep the tank practically full at all times. The pumping station is supplied with a heating boiler with circuits through the reservoir and the riser of the elevated tank to provide against unusual frost conditions.

The Elevated Tank.—The elevated tank is a steel structure of 75,000 gallons capacity, and is carried on four posts. It is provided with a riser 6 feet in diameter. The bottom is elliptical in section. The tank is provided with a mercury pressure indicating gauge and with floats operating the motor switches in the pumping station. The elevated tank, the Moose Jaw pumping station, and the storage reservoir stand in close proximity on what is practically the highest ground in the vicinity of the city.

As stated previously, the infiltration gallery, the headworks pumping station, the pressure main and the headworks reservoir were all done by day labor. The Wm. Newman Company, Limited, Maurice S. Holmes, and the Moose Jaw Construction Company, Limited, were the contractors for the laying of the gravity pipe line, the pipe itself having been supplied by the National Tube Company through the United States Steel Products Company. The storage reservoir and the Moose Jaw pumping station were constructed by the Moose Jaw Construction Company, Limited. George T. Horton, of Chicago, supplied the elevated tank. Drummond, McCall & Company supplied all valves, fittings and specials. The mechanical equipments at the headworks and Moose Jaw pumping stations were supplied by the Canadian Böving Company, Limited, and the Canadian Fairbanks-Morse Company, Limited.

At the present time the infiltration gallery is laid for only about half its contemplated length, and the system of deep wells across the valley to tap the lower supply has not been constructed. The reason for this is that it was considered best to test out the supply this winter with only part of the gallery in operation. Then, if the conditions require it, the balance of the gallery and the deep wells are to be constructed next season. It is quite likely that the present works will be extended so as to include the whole of the development originally contemplated at the headworks.

The Canadian Pacific Railway, the Canadian Northern Railway and the Grand Trunk Pacific will all be active one way or another on the southern part of Vancouver Island. Following that will be expansion further up the Island, so prospects are good.

There are differences in Vancouver over the Canadian Northern Railway agreement, which will shortly be voted on by the people. At the meeting of the board of trade on Tuesday last, a resolution was carried asking that the people vote against the proposition. It is not probable that the board of trade will be seriously heeded in this matter, for the agreement seems to be supported about the city.

COAL STORED UNDER WATER.*

For some time past the attention of those responsible for the control of large industrial and engineering concerns has been centred upon the problem of effectively storing large quantities of coal so as to avoid, or at any rate minimize the risk of spontaneous ignition, and at the same time prevent undue deterioration in quality. As has been frequently pointed out, coals of the bituminous gas-making type (i.e., coals containing about 30 per cent. of volatile matter) are usually found to be affected to a far greater extent than the less volatile steam coals. The unsatisfactory aspect of the whole question, however, is that there is no definite means by which it is possible to ascertain whether or not a certain coal is one which must be regarded with suspicion. In fact, it frequently happens that a stack of apparently harmless coal will heat up without the slightest warning. Hence the only course open to the cautious engineer is to assume that any and every class of coal is liable to ignition, and to subject each consignment—whatever its tendencies—to similar conditions of storage.

The more common method is merely to dump the coal in large stacks, at the same time observing certain well-established rules and ordinary precautions; but another plan, which, however, is seldom adopted in this country, is to submerge the whole stack in a suitable reservoir of water provided for the purpose. This system is viewed with considerable favor by American engineers, and whenever it has been adopted the additional first cost has been found to be more than balanced by the benefit gained in the form of less deterioration, and, of course, perfect freedom from fire. It was originally suggested by a dock engineer who carried out a number of experiments on pieces of coal which had been accidentally split during transference from ship to shore, and which were subsequently recovered from the river bed. This coal, part of which had probably been submerged for some considerable period, showed on analysis a surprisingly small amount of deterioration, and the same results were obtained when experiments were made with larger amounts. In some cases the dredged coal had been immersed for at least ten years, and even then it was found to have lost little of its original value; while in the case of samples immersed for about three years the deterioration was estimated to amount to less than 3 per cent. This is, of course, a remarkably low figure when compared with that for ordinary bituminous coals stacked in the open in this country, for they invariably show a decrease in value of from 5 to 8 per cent. in the course of 12 months. In more tropical countries, and in climates in which variations and extremes of temperature are abnormal, the loss is naturally very much greater. For instance, coal of the Navy type stored in Hong-kong is said to suffer to the extent of from 20 to 40 per cent. If this is the case with a steam coal, the corresponding amount of deterioration of a bituminous coal would be a somewhat serious consideration.

Advantages of Wet Storage.—If it were possible to maintain an equable and moderately low temperature throughout a coal stack there would probably be little trouble with spontaneous firing, and it is in this respect that the wet method is superior to any other. Nowadays coal stocks kept in hand by industrial concerns are in many cases far too large to be provided with shelter from the weather, and are consequently subjected to varying conditions of snow, rain, frost, and sun. When submerged, however, the material is protected more adequately than if it were housed; and, no matter what are the weather conditions, the variation in temperature of the mass will be comparatively small. It is now generally

*From Scientific Supplement of London Times.

recognized that the gases occluded in the pores of the coal—more particularly oxygen—are indirectly the cause of both heating and deterioration, and their escape should as far as possible be arrested. By immersing coal and keeping it continually sealed this condition is fulfilled, the gases being more or less confined, while little or no oxidation takes place. The breaking up of lumps and pulverization are considerably reduced, because the water forms a cushion between the various pieces, thus lessening the effect of the movement of the lumps one on another, though the better physical condition of the coal is probably due in part to absence of heat, which in itself is to a great extent the cause of the opening out and disintegration of the larger pieces.

Authorities on the question of coal storage are now generally agreed that no air-stacked heap—whether housed or in the open—should be taken to a greater height than about 20 ft., chiefly on account of the danger of the formation of "dust-pockets," which are frequently the primary cause of ignition. There is, however, no limiting depth in the case of an immersed stack, and accordingly a considerable saving of space can be effected. This, again, is a material consideration from the point of view of works lying in the centre of congested districts, where vacant spaces are limited and the price of land excessive. For instance, if 20ft. is to be the maximum height of the stack, the storage capacity is limited to between 40 and 50 tons per 10 sq. yards of ground area, and thus an acre of ground space will accommodate, at the outside, only some 20,000 tons—by no means an excessive quantity in view of the huge demands of industries such as gas-making, in which the larger works carbonize as many as 1,000 to 2,000 tons a day, and in some cases even greater quantities. By adopting the wet storage method the capacity per unit of ground area could certainly be doubled, and there is no reason why it should not be even greater.

Possible Defects.—With all its possibilities and advantages, the storage of coal under water is sure to introduce a certain number of undesirable factors, and perhaps the most serious question to be taken into account is that of expense. At present the cost of stacking coal is considered to be no more than the value of the ground upon which the coal stands, although in addition there should be reckoned the expenses of constant supervision and labor in turning over and working out suspicious parts of the heap. The expense of conveyance to and from the stack may be neglected, because it is necessary in both cases, the extra depth in the wet method being balanced by the saving of distance.

The coal reservoirs—usually constructed of reinforced concrete—must, of course, be designed with foundations varying in accordance with the proposed depth, and in the event of the latter being considerable the expense is somewhat heavily increased owing to the great pressure on the floor and side walls. A further consideration is that of pumping machinery for emptying or filling purposes.

A contingency which must not be overlooked is the possibility of sudden frost and the consequent freezing up of the reservoir to some considerable depth. It is improbable that anything of the kind would occur in this country, and in places where intense cold prevails wet storage would be unnecessary owing to the limited amount of deterioration and greater immunity from fire in such climates.

There is, however, an admirable system in vogue known as the "mixed method," according to which a supply of coal is stored in the open for immediate requirements, and the deficiencies are made good by deliveries. At the same time a certain quantity is stored in the water reservoirs, and this is set aside for use in the case of emergency only. Even should ten years elapse before an emergency arises, the coal (as previously pointed out) should be found to have deteriorated to only a very slight extent.

One of the largest reservoirs constructed for the purpose of storing coal under water is that which it was decided to erect at Stettin about two years ago. The tanks, on the banks of the River Oder, were designed to be capable of dealing with 20,000 tons. Towards the close of 1911 arrangements were also completed for storing 6,000 tons of coal in this way at the works of the Omaha Electric Light and Power Company, and a most elaborate coal handling plant was erected for working in conjunction with the tanks. In this case the tanks are comparatively shallow, their depth being 22ft., and the side walls are carried on piles owing to a treacherous stratum of quicksand. Piles at a pitch of 5ft. were also driven under the whole of the floor area and capped with square slabs of concrete, upon which the floor rests. In this way the whole of the load is brought upon the piles and none of it is upon the earth. The side walls are about 2ft. thick at the top and 4ft. 6in. at the bottom, and the concrete floor is protected from the bite of the coal "grab" by means of embedded rails.

Effects of Using Wet Coal.—When coal has been subjected to storage under water for any length of time it is usually found to be somewhat brittle and decidedly dull in appearance. But the latter effect is merely superficial, and on drying in the sun it rapidly disappears. In many cases, however, time would not permit of the coal being set aside for drying, and the consumer would be faced with the difficulty of using fuel containing a high percentage of water. For steam-raising and all firing purposes this would no doubt be of little account, but the question cannot be considered lightly when the coal is destined for gas-making purposes. It has long been a general belief—probably an exaggerated one—that if wet coal is carbonized in gas retorts the proportion of impurities will be increased and, in addition, greater quantities of the much-maligned hydrocarbon naphthalene will be evolved. Thus the storing of coal under water would be likely to meet with stout opposition from the gas engineer. However, full charges of coal (that is, charges that completely fill the retorts) are now the order of the day in the gas world, and under such conditions the moisture has practically no evil effect. At any rate, it should be found more profitable to carbonize a wet coal giving a slightly increased yield of impurities than an air-stacked coal which had lost perhaps 10 per cent. of its gas-making value.

SAFETY FIRST.

The Canadian Pacific Railway Company has ordered a sheet filled with mottoes of "safety first" propaganda for distribution. Points already emphasized by numerous safety committees are brought out, as follows:—

I will not stand in front of a moving car, or engine, to board same.

I will always respect the blue flag, because the lives of my fellow-employees depend upon it.

I will not hold on to the side of a car when passing platforms, buildings or obstructions close to the track.

I will not shove cars into a freight shed, or on team tracks, without first making sure that all men and teams are clear.

I will not kick cars into sidings, where boarding cars, or cars being loaded, or unloaded, are standing.

I will remember that it is better to let a train wait than to cause an accident.

I believe that Safety First is simply a habit and I will cultivate the habit.

The prevention of accidents is a duty I owe myself, my family, and my fellow-employees.

I will take out immediately sufficient accident and life insurance to protect myself and those dependent upon me.

MAMMOTH FLOATING DOCK.

Paralleling the increase in size and tonnage of ocean-going ships of was is the tremendous size of floating dry-dock constructed to handle them. Lately in England there was placed at Portsmouth a floating dock capable of handling the heaviest of British battleships. An interesting chat about this monster, written by S. A. Mackenzie, a pupil at Queen's Engineering Works, and printed in the Queen's Engineering Works Magazine, follows. The battleship "Monarch," which is spoken of is one of the largest and latest in the British navy. Completed in 1912, it is of 22,500 tons displacement, 27,000 I.H.P., and speed of 21 knots. It has turbine engines and a main armament of ten 13.5-inch guns.

The floating dock, constructed by Messrs. Cammell, Laird and Company, Limited, at Birkenhead, for the British government, at a cost of over a million sterling, is capable of raising a ship of 32,000 tons. It consists of a series of tanks, the total length of which is 680 feet and the breadth 150 feet. On either side two walls 15 feet wide rise to a height of 46 feet above the pontoon deck. These walls are connected by a swing bridge for use when there is no ship in dock.

Along the bottom of the tanks a line of pipes is run with a branch-piece and valve to each tank. These valves are controlled from the valve-house on deck and are worked by compressed air. The air is admitted through a cock opened by means of an electro-magnet, the current being switched on in the valve-house. A switchboard is provided on each side of the valve-house, the position of the switches corresponding to their respective tanks, while above each switch are indicators showing whether the valve is open or shut, and the level of the water in the tank.

The controller can watch the performance of the dock by means of two spirit levels set at right angles.

Placed between the sides of the walls and just below the upper deck are the compartments containing the machinery for working the dock. At each corner are two boilers, and adjoining each boiler-room two horizontal open engines, with vertical shafts which drive the 16-inch centrifugal pumps that are used for raising the dock. These are placed at the bottom of the dock. A condensing plant and fire-pumps, etc., are installed below each engine-room. Throughout the dock is a complete installation of electric light.

The dynamo-rooms are situated at about the middle of the dock on either side, and each contains two Allen 200-kw. sets, consisting of enclosed vertical engines and shunt wound continuous current dynamos. It was in connection with the erection and running of these that I was fortunate in spending several weeks on board the dock. The switchboards are arranged so that all four machines can be run in parallel for supplying current for the dock itself, and to the ship in the dock; also by means of two-way switches either machine can be connected direct to the ship. The voltage of the main generators being 225 volts, two motor-generators (one in each dynamo-room) are provided, with a range of 85 to 115 volts, for giving current to ships with lower voltages. In each dynamo-room is a motor-driven air-compressor for working the valves, pneumatic tools, etc.

On the starboard side of the dock is a large workshop containing lathes, planing, drilling, and screw-cutting machines, punching and shearing machines, while in the smith's shop is a steam-hammer and a set of rollers. The top deck on either side is provided with four steam-driven capstans and a 5-ton electrically driven crane, travelling the whole length of the deck.

On the port side, cabins and a wardroom for the accommodation of twelve men are provided; also extensive lavatories and wash places for the crews of ships in the dock.

The dock was built in a specially constructed basin having a large temporary dam, and when complete a portion of the dam was cut away, and the tide allowed to flow under the dock. Some little difficulty was experienced in getting the dock out of the basin. A high wind was blowing at the time which, catching the walls of the dock, drove it into one side of the dam, where it remained for nearly half an hour, all efforts of the tugs proving unavailing. Anxiety prevailed lest the tide should go down before the dock could be got clear. At last, with a rending of timber, the dock slowly moved forward, carrying with it about fifteen feet more of the dam. Owing to the very strong current in the Mersey it required ten tugs to convey the dock safely to the bar. Here six of the tugs left us, taking with them the men who had assisted in getting us away. We then continued our journey to Portsmouth, and next morning arrived off Holyhead.

The weather was very rough during the whole of the voyage round, but with the dock covering such a great area we could scarcely feet the motion of the sea at all. It seemed very strange to stand on the bridge and watch the tugs rolling and pitching about, while we felt as though we were on terra firma.

Coming up the English Channel the tugs were pulling at right angles to the dock nearly the whole of the time, the wind creating so much pressure on the walls that we were travelling sideways.

A cross-channel steamer seeing us in this position, and being unable to read our signals, sent a wireless message to the shore that we were in difficulties. A cruiser was sent after us from Portland, but on learning we did not require any assistance she turned back.

On arrival at Spithead, it was too windy for us to go into harbor, so we had to put to sea again, and lie off the Isle of Wight all night. Next morning, however, the wind had dropped considerably, and four dockyard tugs came out and towed us safely into Portsmouth harbor, after being eight days at sea.

During the voyage, many amusements were resorted to to pass away the time. Cricket, running and jumping afforded good exercise, while fishing was greatly indulged in, but, sad to relate, only three small mackerel were caught during the whole time we were at sea.

At Portsmouth the trials were satisfactorily carried out, the dock raising H.M.S. "Monarch."

TRADE DISPUTES SHOW DECREASES BOTH IN NUMBER AND MAGNITUDE.

There was further improvement in industrial conditions in regard to the number of trade disputes during January. At the end of the year 1912, there were seven disputes in existence of such magnitude as to affect industrial conditions and two of these were settled during January. Five new disputes occurred, a feature of which was the fact that by none of them were more than one hundred employees affected. Disputes in existence in January were twelve in number as compared with thirteen during December. The number of employees affected also showed a decrease, being 2,208 as compared with 3,850 during December. The number of working days lost during January was about 48,000, which represents a decrease of more than 18,000 as compared with the December record. There were seven disputes left unterminated at the end of the month.

REPORT OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

This report of the proceedings of the annual meeting of the Canadian Society of Civil Engineers, held in Montreal January 28th, 29th and 30th, 1913, is continued from the February 6th issue of The Canadian Engineer. In that issue the proceedings of Tuesday, January 28th, appeared.

On Wednesday, January 29th, during the morning, the members inspected the Montreal Steel Works at Longue Pointe.

Afternoon Session,
January 29th, 1913

THE PRESIDENT stated that they were dealing yesterday morning with the reports from the branches. He thought they had better go on with the reports of committees.

REPORTS OF COMMITTEES

Report of Committee on Establishment of Testing Laboratories

THE PRESIDENT said the first report was that on the establishment of Testing Laboratories.

MR. MACKAY, one of the members of the committee, said they had not held any meetings during the past year so far as he was aware, so there was nothing he could add to the printed report. Of course, the changes mentioned in the administration of the Department of Public Works doubtless were responsible to a very large extent for the small amount of progress made.

THE PRESIDENT asked if it was the wish of the meeting that the report be received as a progress report and adopted, and that the committee be continued as it stood?

This was carried.

Report of Committee on Educational Requirements

The next committee was that on educational requirements, of which Mr. Marceau was chairman. As he was not present the next report was taken up.

Report of the Examiners' Board

THE PRESIDENT asked Professor Mackay, as chairman of the Examiners' Board, to discuss the report.

MR. MACKAY said that although the report of the Examiners' Board was short, the Board had done a good deal of work during the time it had been organized, the last ten months. The most difficult task was to draw up a syllabus of the examinations, because they had little guidance to help them in that respect, and they were rather between two difficulties, one to set a standard that would really mean something, and the other to make that standard such that no worthy applicant should be rejected. Whether they had succeeded in accomplishing that task he did not know. They certainly had so far to their own satisfaction, but they realized the work at present was only in the experimental stage. The syllabus of the examination should be drawn up and printed, and also a complete set of examination papers, which might serve as some indication of the standard required in Canada. Also a set of examination papers should be printed on the subjects for which candidates presented themselves at the second examination. Two examinations were held. As there was but little time to prepare for those examinations, only a small number of candidates came up this year, most of whom, he thought, succeeded in passing. The committee had also been called upon to examine a large number of certificates presented by men who, although they were not under the strict regulation exempt from examination, still were able to present certificates of educational acquirements which might reasonably be looked into and accepted. Some of these, of course, were accepted and some rejected, and that involved a considerable amount of work. He was sure all the members of the Board would be very glad to receive any suggestions to guide them in continuing the work. It was to the benefit of the Society that they should do so.

MR. SKAIFE thought this committee was a very important one, and they should make it as prominent as possible. One good reason is that if this Society was recognized as an educational Society they ought to be able to secure exemption from taxes, which amount to over $800 a year. He wrote to the committee about that some time ago. When the Government of Quebec regards the Society as an institution of that kind, the City Council would fall into line. He knew it had been the policy all along to encourage education in the province.

THE PRESIDENT thought the Society ought to be considered as an educational institution. They were doing their best to elevate the standard of the engineering profession.

The resolution for the adoption of the report was then put and carried.

Report of the Quebec Branch

THE PRESIDENT then took up the report of the Quebec branch, which had been passed over a few minutes ago because no one was ready.

The report was then read by the Secretary.

MR. DODWELL moved that the report be received and filed.

Carried.

Report of the Canadian Committee of the International Electro-Technical Commission

THE PRESIDENT said the next report was that of the Committee of the International Electrotechnical Commission, and called on Dr. Herdt.

Dr. Herdt said a few words might be added to this report in order that the members might know exactly what was being done.

The Canadian Committee was appointed by the Council of this Society to join with the committees appointed by practically all the great countries of the world to form an Electrotechnical Commission, whose duty is to standardize electrical symbols and also to go into the matter of the standardization of electrical machinery. These committees

appoint delegates to annual meetings which are held in different parts of the world. The last meeting was held at Turin, Italy; the next will be held at Zurich, Switzerland.

The Society had a delegate sent from Canada to the last annual meeting. The recommendations made by the different committees were considered, and some of them amended, others approved. As might be understood, such work is, of course, very slow, a great deal of it having to be done by correspondence, as no recommendation can be carried before it has been submitted to the different committees. Publications have been issued by the commission, which had to be submitted to the different committees for approval.

The largest amount of work had been done in relation to the standardization of symbols. It was very difficult in taking up a text book on electrical matters to understand exactly what the different symbols used exactly meant. The committees have practically settled on uniform symbols to denote the various terms in electrical machinery and electrical engineering.

Several committees have been appointed by the different countries in regard to electrical machinery. This is with a view of standardizing principally the rating of electrical machinery, so that when a machine is rated at a certain kilowatt capacity, or horse power, it will have the same meaning throughout the world. The Society committee has been doing considerable work by meeting either in Ottawa or Montreal, getting members together, and making recommendations.

Dr. Herdt hoped this report would be carried by the meeting, and that the members of the committee would be allowed to continue this work for the succeeding year. In that way they would keep in touch with the subject, which was of great importance to Canada, as this country is becoming a large centre for electrical machinery and provides unlimited scope for electrical engineering. (Applause.)

THE PRESIDENT asked if it was the pleasure of the meeting that this report be received and adopted, and the committee continued?

MR. VAUGHAN asked if it would not be a good scheme to reconsider the matter of appointing committees by the general meeting? Why not have them appointed by the council, subject to any suggestions the general meeting wanted to make? They were continuing committees from year to year, and after action was taken by the general meeting the council was powerless to add to a committee, change it, or reach it in any way.

MR. MONSARRAT thought Mr. Vaughan's remarks were well chosen. For instance, in some committees the members were very far spread and during the year they did nothing. In the meantime the council had no power to make any changes. It seemed to him the council ought to have such power so they could make any necessary changes recommended by the Chairman.

DR. HERDT said it was doubtful whether the Canadian Society of Civil Engineers had any jurisdiction over this work. The International Electrotechnical Commission was appointed in England some years ago, and it was understood at that time that the members of these different committees would be appointed by the technical societies and the manufacturing interests of each country, and that if they did not appoint these committees the government would do so. He was present at the first meeting of this commission in London, England, three years ago. He was a member of the special committee which had to draft out rules and regulations governing that commission, and he had pointed out to the different members present, that in Canada at that time they had only one engineering society, and that the Canadian Society of Civil Engineers was really a parent society embracing all engineers, that is, civil, electrical and mechanical. The Dominion Government the first year naturally stepped in and appointed a committee, and practically up to last year sustained it. It had since been continued with funds obtained from individuals and from the commission. They had to send in each year $200 to the Secretary's office in London, and looked after their own expenses. The Canadian Society of Civil Engineers subscribed last year $100, which was only a small portion of the expense they had had to carry themselves. The Canadian manufacturers had subscribed liberally to this work, and individually they had subscribed.

This committee was a very representative one. It consisted, besides himself, of Mr. Higman, who represented the Dominion Government; Dr. Barnes, who represented McGill University; Mr. L. W. Gill, who represented Queen's; Mr. T. R. Roseburgh, who represented Toronto; Mr. Duff, who represented the West; Mr. Kynoch, who represented the Canadian General Electric Company; Mr. Murphy was the electrical adviser of the Board of Railway Commissioners, and Mr. Lambe, the secretary, was also at the head office in Ottawa. So a number of these gentlemen might not be members of the Society of Civil Engineers, and there was nothing in the constitution of this commission to say that they must be members.

He felt very strongly that unless this Society continued their support, morally and otherwise, to this work the committee would have to look elsewhere for assistance. Personally, he had been for a number of years asked by the American Electrical Engineers to join in the formation in Canada of a branch of the American Institute of Electrical Engineers. He had stood against that, and, as they knew, there was no branch of the American Institute in Montreal at the present time, because he thought the Canadian Society should cover the whole engineering field. (Hear, hear.)

When it was discussed as to who should vote, it was decided that each country should have one vote, and Canada was the only country which has a vote outside of great countries like France, England, Norway and Sweden. Thus they were recognized as practically being autonomous, and their importance in this branch of engineering acknowledged.

Therefore he would ask that at this meeting the Society continue its support to this committee, as the work they were trying to do with the other countries was of very great national importance. (Applause.)

MR. MONSARRAT said what he thought was intended by Mr. Vaughan's remarks, and what he intended, was not that they should not support this particular committee, but that the council might have power to change committees on the Chairman's recommendation, and if the Chairman was satisfied with his committee he would not recommend any changes. This was merely giving the council such power as was necessary, so that instead of carrying a lot of dead wood, action might be taken from time to time to strengthen any committee.

THE PRESIDENT said this was a special committee over which they did not have very much jurisdiction. He did not think there should be any change made in this committee. In fact, they had not power to make any change in it.

MR. MURDOCK moved that that report be accepted and the committee continued. It appeared to him the last speaker's argument was a very strong one for leaving the committee alone.

Duly seconded and carried.

MR. MOUNTAIN replying to Mr. Monsarrat's question, said at the present moment all committees had power to add to their number. If they found there was dead wood on,

they need not strike such members off, but there was power to add new members.

THE PRESIDENT said the next committee was that on Specification for Steel Bridges, of which Mr. Monsarrat was Chairman.

Report of Committee on Specification for Steel Bridges

MR. VAUGHAN moved that the report be received and a committee appointed by the council to continue the work.

MR. MOUNTAIN wanted to know from this committee if it was their proposal to make the specification of the Canadian Society of Civil Engineers a standard for steel bridges.

THE PRESIDENT said that was the proposal.

MR. MOUNTAIN asked if this meant that the specification for fixed spans was adopted.

MR. MONSARRAT said yes.

MR. MOUNTAIN said on this committee were the bridge engineers of the Canadian Pacific, the Grand Trunk Pacific and the Grand Trunk Railways, and the Chief Engineer of the Department of Railways and Canals. All those men were working under more or less different specifications, and his enquiry was this: If in signing this as members they have agreed, or will agree, to make the standard of the Canadian Society of Civil Engineers their standard? He would tell them why. The Canadian Northern Bridge Engineer, who was present, Mr. Chapman, was not on this committee. Most of these railroads from time to time have branches that have been, or are, subsidized roads. Under their contract with the government they are obliged to build their bridges to the specification of the Department of Railways and Canals. In course of time those bridges are altered, not likely because they have become decayed or rotted out, but in most cases on account of heavier motive power being used. Then these roads come back with another specification on which to build these bridges. All bridges built by all these roads mentioned have got to come before the Dominion Railway Board in his (Mr. Mountain's) department. To-day he was dealing with a specification gotten up by the Department of Railways and Canals, which the Board accepts; he was dealing with the American Engineers' Maintenance of Way specification for the Grand Trunk Railway; he was dealing with the Dominion Government specification for the Grand Trunk Pacific; he was dealing with the Canadian Pacific's own specification for the C.P.R.; and the Michigan Central have got another. His idea was this, that if the Canadian Society of Civil Engineers, with these men on that committee, feel that they can see their way to making one standard specification for steel bridges, he was prepared to recommend to his Board the adoption of that standard, and bridges will be passed on that standard, and on that standard only. He might say that Mr. Uniacke, the bridge engineer of the National Transcontinental, is also on that committee. He would like to get the views of those gentleman on that question.

MR. MONSARRAT said that was one of the principal ideas they had in drafting this specification, to try and get some uniformity, and he thought the gentlemen who are on this committee would agree with Mr. Mountain's wishes, that they will adopt that as their standard, with possibly a few changes in some minor paragraphs. It was very hard to get a specification that everybody agrees to exactly all the way through, but the general specification could be adopted, and he had reason to believe that this specification would also be adopted by the Department of Railways and Canals, and so make for uniform practice throughout the country.

MR. SULLIVAN said he could not agree for his company. It would be the most unfortunate thing that ever happened to the railways and the public of Canada that such a policy should be carried out. Write up that specification as a standard and nobody had authority to change it. If the Board of Railway Commissioners make a standard, everybody has to stick to it. It would be the beginning of retrogression. He was chairman of a committee that has done some work, but if this Society was going to vote that that specification be made a standard in any department of the government, and compel people to adhere to it, he would vote against it. This Society's recommendations should be educational in form, that is, recommend this as good practice; but every member, student and engineer in the country should have the right and privilege of varying from that specification to suit particular conditions. He would never believe anything else.

MR. DUGGAN said as a member of that committee, he was very much in accord with Mr. Sullivan. All these bridge engineers are not of one mind necessarily as to what is the best practice. The committee got all their opinions together and brought them as far as possible into unison, and put up what necessarily is a sort of compromise specification as being the average opinion of all the men who are more or less expert in that work. As Mr. Sullivan said, they simply put that forward as representing what they thought was the best practice. He thought the Department of Railways and Canals should adopt this specification, but there was no reason why every railroad should also adopt the same specification.

MR. MOUNTAN said he had not made himself clear. No railroad gets a subsidy unless it builds its bridges in accordance with the standard laid down by the Department of Railways and Canals.

MR. DUGGAN corrected him and said, up to that standard.

MR. MOUNTAIN said whether it was the Canadian Pacific, or the Grand Trunk Pacific, they were building to the Department of Railways and Canals specification. The Grand Trunk Pacific are obliged to under their contract with the government. This is what occurs. A railroad is located and plans are submitted to the Railway Board for approval. The company builds its bridges under the American Engineering Maintenance of Way Association specification. The Chief Engineer in presenting the plans states what they are. He is asked if it is a subsidized road. He says, "Yes." He is asked if he has submitted those to the Department of Railways and Canals. He says "No," because until the plans go through your Board they cannot go to them, you fix the location. They are passed under their own standard, say the Canadian Pacific Railway standard. Then they submit under the subsidy contract plans and specifications for those bridges, and they are obliged to conform to the department's specifications.

Three years ago this Society made a standard for water pipes, sewers, etc. (Mr. Ker, City Engineer of Ottawa, was chairman of the committee), for putting crossings under railway tracks. That standard was adopted by the Railway Board and put in their rules and regulations. Now an order simply goes out that the pipes shall be carried under the railway in accordance with the standard of the Canadian Society of Civil Engineers. It has remained so, and it is lived up to.

THE PRESIDENT said that, of course, the Society cannot in any way control the different railways. The mere fact that the Bridge Engineer of each railway company was on this committee does not commit his railroad.

MR. MONSARRAT said that he did not see why it would be really worse to have this specification than the one the government has at present.

MR. SULLIVAN said the government specification was a general specification; this goes very much into detail.

MR. DUGGAN said he was afraid that Mr. Sullivan did not fully understand this specification. This was mostly on the same lines as the Canadian Pacific specification, the Grand Trunk specification, the American Maintenance of Way specification, and the specification of the Dominion Government. There was some difference in practice in matters of loading. This specification, as drawn up, allowed for choice of loading, etc., just exactly as did the Maintenance of Way and the Grand Trunk specifications, and to a certain extent the C.P.R.'s specification. There were some minor changes, but it was simply a matter of codifying the best existing specifications of the day, and with a view to revision of the government specification, which was a little antiquated. He did not think the government would tread on the toes of any railway if it adopted this specification as the standard of good practice, and left the railways free to make it better if they saw fit; but this ought to be the lowest standard.

MR. SULLIVAN said he was speaking in general terms on general principles. The principle of this Society in adopting a certain specification and urging that it be adopted by the railways and by the government was wrong. He had not read the specification, and possibly it was so general that it might not do any harm, but the principle was wrong.

MR. MONSARRAT said with regard to using wooden ties, or a steel floor, or a ballasted floor, there was nothing in the specification to prevent it.

MR. SULLIVAN said he was simply trying to bring out the point that the attempt to get all railways to adopt one specification and agree to it without change was wrong in principle. He belonged to the Maintenance of Way Engineers' Association, and he presumed that 99 per cent. of the work that was done in the grading and building of railroads was in accordance generally with the Association's specification, but he did not think three per cent. of the railroads had adopted that in its entirety without changes. The principle was right to have a specification that would tend to uniformity, but to make that the only standard was wrong.

MR. KENNEDY said they could not pretend to legislate for the whole country, and the putting out of this specification did not tie up anybody.

THE PRESIDENT said in putting out this specification they could only put it forward as the Canadian Society's specification and they could not in any way make any pretense of saying to the Canadian Pacific, the Grand Trunk, or any other road, that that must be their specification. They could adopt any specification. On the other hand, in regard to the Railway Commission, it seemed to him that they must have something to guide them in dealing with the railways, and the better the specification is the better for the railways; that is, the more perfect it is in its get-up the better it is for the railways. This specification has certainly been gotten up by the best bridge engineers in the country, and it seemed to him, from a Railway Commission standpoint, that it would be better they should adopt it, if it were a satisfactory one, (as it should be under the conditions) than that the Railway Commission should appoint some engineer of their own to draw up a specification. The mere fact that this specification was adopted by the Railway Commission could not make it a standard for the railways, although in a certain sense, if it is the Commission's standard the railways must live up to it, although they may go beyond. Therefore, it seemed to him that Mr. Sullivan was hardly clear in his point. The Railway Commission had an undoubted right to get up a specification if they so desire, and they have the power to enforce it on the railways. His point was this, that if the Railway Commission were going to have a specification, it was better in the interests of all concerned that they have a specification gotten up by this very eminent body of engineers than that they adopt one made by themselves, that they will get better results from this body than from any other body in Canada. They had no power to enforce it on the Railway Commission, but if they wished to adopt it there was no power that can prevent them.

The motion that the report be adopted, and that a committee to carry on the work be appointed by the Council, was put and carried.

Report of the Committee on Conservation.

MR. WHITE did not think any extended remarks were necessary in regard to that.

The matter was brought to the attention of the committee, as would be seen in the initial paragraph, by a letter from Mr. Sauder, dealing with the question of the organization and provision of the necessary staff to gauge streams in Canada. The preliminary portion of the report was somewhat of an academic nature, and then followed a brief statement of what had already been done in the various provinces of Canada.

In Nova Scotia some work had been done by the Commission of Conservation. In New Brunswick the Commission had also done some work, and also the St. John River Commission. In Quebec they had gauges at some of the canals, and gauging had also been done by private concerns. In Ontario they had the Hydro-Electric Commission and also the Department of the Interior, the International Joint Commission, and the Department of Public Works. In the Northwest all the work had been done by two branches, the Department of the Interior supplemented by the Department of Public Works. In British Columbia the work was being done by the Conservation Commission.

He had just run briefly over the work that was being done in the various provinces to show the diverse organizations that were engaged upon this work, and anyone who appreciated the value of this work could see at a glance that it was far better that this work should be concentrated in some shape or form. The committee made a few recommendations, which would be found at the end.

The recommendations in brief were that it would be advisable that this work be concentrated in some shape or form, and that preferably some Dominion organization should undertake the work. But the committee did not make that a recommendation concerning action by the Society. He understood from Mr. Mitchell, who was also a member of the committee, that he had a motion to make in connection with that.

MR. MITCHELL said what he had to propose was not with reference to the continuation of the work of the committee. He thought that should proceed. He thought it was the desire of all the members that the committee's work should continue, because they were charged with the state question of conservation. What the burden of this report had reference to was stream measurement. As they all knew, that was one of the most important features they had to deal with in Canada at the present time, particularly in reference to the development of the country, and as was very evident from the report, and as had been pointed out by Mr. White, there was great confusion in the methods of investigation of stream measure throughout Canada. There were many bodies which were carrying on those investigations, and there was comparatively little uniformity in doing the work,

while the results were put in various forms and kept in various places.

He had a proposal to make which was entirely separate from the question of the continuation of this committee, and it was that the question of stream measurement be taken up by the Council of the Society directly as representing this Society, and that an effort be made to interest the various Government Departments of the Dominion and the Provinces, looking towards co-ordination of these various investigations. He thought it was the place of the Council of the Society to initiate this, rather than that of a Committee of the Society. The Council was a more stable element, and was perhaps in many ways better able to carry on this work than a Committee which was spread from coast to coast and of such a character that the work would fall on two or three members of the Committee. Consequently he presented this motion:—

Whereas this Society is of the opinion that it would be to the general advantage of Canada if a comprehensive system of hydrographic surveys was organized and prosecuted by some central body, with special reference to stream measurement;

Be it resolved that the Council of this Society be directed to initiate with the proper officers of the Dominion Government and the various Provincial Governments a proposal looking to the co-ordination of all stream measurement investigations which are now being carried on by the several Dominion and Provincial Government departments in various regions of the country, with the ultimate object of consolidating and continuing such investigations under some central body.

It was the desire not to specify how this could be done, or what that central body might be, but he thought it would be much to the credit of this Society, and it would be a very fruitful piece of work to the country, if this Society could initiate some movement which would co-ordinate this work into some commission or some department of the government. It was not for the Society to say, but it was for the Council to say if some such arrangement could not be made.

MR. WHITE said, in reference to Mr. Mitchell's remarks, he wanted to make clear what he intended to say at the outset. The Commission of Conservation had done some work in this connection, but it was done very much against his will, and the commission will not do any work of this character which it can induce any other organization to undertake. It must be taken up in practice by some Department of the Government; that was a matter of course. The Commission of Conservation could not undertake this work. He took this opportunity to emphasize this, otherwise someone present might think that because of his connection with the Commission he wanted this resolution passed.

MR. McCOLL seconded Mr. Mitchell's motion.

The motion was then put and carried.

The other motion, that this report be adopted and the committee continued, was adopted unanimously.

MR. MITCHELL moved that two additional names be added to the committee, namely, Mr. J. B. Challies, superintendent of water powers in the Department of the Interior, and Mr. P. M. Sauder, the chief hydrographer of the Irrigation Branch of the same Department.

Seconded.

MR. OLIVER moved an amendment to the motion that these names be sent on to the committee, with a recommendation that they be added to the committee.

MR. MITCHELL, with the assent of his seconder, withdrew his motion in favor of the amendment proposed by Mr. Oliver.

THE PRESIDENT said that this motion was now in the form of a suggestion to the committee that they add those two names to the membership.

Carried.

Then the motion that this report be received and adopted and the committee continued was carried.

THE PRESIDENT then said that in addition to these reports a number of the committees had not reported at all. Two committees did report, but not in time, namely, the Roadbed and Ballasting and the Good Roads Committees. These are specifications rather, and they have not been sent to the members, so that they are not in a position for this meeting to act upon them.

There were also no reports from the Committees on Railway Ties, Transportation Routes, Rail Fastenings and Tie Plates, Cement Specifications and Sewage Disposal.

He confessed to considerable surprise and disappointment that there was no report from one of these committees especially, and that is the one on Cement Specification. He asked the pleasure of the meeting in regard to the committees which had not reported.

A MEMBER moved that the Council be empowered to reappoint them, or appoint other committees in their place.

Seconded and carried.

NEW BUSINESS

THE PRESIDENT here said in connection with new business he would like to get the proposals of British Columbia before the meeting. It was getting late, but the matter was important. He would be glad to hear from the representatives of the Vancouver Branch.

MR. ROBINSON said there were very many matters which frequently came up before the engineers of British Columbia that could best be taken care of if the large number of engineers residing in British Columbia and members of this Society could in some manner co-operate, to the end that their interests will be taken care of. It had frequently happened that the Society, as a Society, had had to appeal to the Provincial Government on matters which should properly come from the Canadian Society of Civil Engineers at the Montreal headquarters. But, unfortunately, matters moved so quickly in the West that they had not time to institute the proper proceedings and appeal to headquarters here and get action from the Council and return answers to the British Columbia engineers until matters have gone so far as to make it impossible to apply any remedy.

They would like to have this Society give the engineers of British Columbia authority to assemble and transact such business as requires immediate action; but let them have a set of by-laws framed up and thoroughly approved by the Council. Make those by-laws uniform if they wished. They did not desire to separate from the Society of Canadian Engineers, nothing of the kind, and they did not wish even to take any powers of government from the main Society, but they would like to have the main Society make it possible for them to be a unit recognizable by the Provincial Government. Let them realize that this Society is established in British Colnmbia. That was the point.

He had not framed the exact wording of a resolution to carry this into effect, but he thought he could safely leave it in their hands for some impartial person to frame a resolution which will permit the British Columbia engineers to get together in a unit for the protection and the advancement of the profession which they represented.

After a long discussion on the question, the meeting was adjourned, the matter to be further discussed the following day.

(To be continued next week.)

ONTARIO LAND SURVEYORS.

The Ontario Land Surveyors held their twenty-first annual meeting on the 25th, 26th and 27th of February, at the Engineers' Club, King Street West, Toronto. Their banquet, Wednesday evening, was a great success and most enjoyable. Several friends and representatives of sister societies of the association were present to enjoy their hospitality and programme. Among these was the Honorable Mr. Hearst, Minister of Lands, who attended and gave a very fine speech. The programme was as follows, and some of the papers presented will be published in The Canadian Engineer shortly.

TUESDAY, 25th FEBRUARY.

Morning, 10 O'clock.—Meeting of Council of Management; meeting of standing and special committees.

Afternoon, 2 O'clock.—Reading of minutes of previous meeting; correspondence; president's address, T. B. Speight; report of council of management; report of the secretary-treasurer; report of the board of examiners; report of committee on legislation, G. B. Kirkpatrick, chairman; report of committee on publication, A. J. VanNostrand, chairman; report of committee on topographical survey, Thos. Fawcett, chairman; report of committee on exploration, J. F. Whitson, chairman; paper, "Colonization in Northern Ontario," H. M. Anderson; paper, "Aliquot Parts of Township Lots," J. S. Dobie; paper, "Gold Mining in Yukon," E. D. Bolton; paper, "International Boundary Survey East of the St. Lawrence River," Thos. Fawcett.

Evening, 8 O'clock.—Lecture on Panama Canal, A. J. Grant, superintending engineer, Trent Valley Canal, Peterborough; paper, "Modern Engineering Improvements," J. G. Sing, district engineer, Ontario Division Dominion Public Works.

WEDNESDAY, 26th FEBRUARY.

Morning, 10 O'clock.—Report of committee on land surveying, C. J. Murphy, chairman; report of committee on polar research, Willis Chipman, chairman; paper, "Methods of Subdivision of Nine Mile Townships in Ontario," H. J. Beatty; paper, "Subdivision Surveys in Alberta," C. E. Bush; paper, "Boundary Line Between Augusta and Edwardsburg Townships," Willis Chipman; paper, "Notes on Survey Act," C. H. Fullerton; paper, "Diagonal Street Surveys in Great Britain and Canada," T. D. LeMay.

Afternoon, 2 O'clock.—Report of committee on engineering, Owen McKay, chairman; report of committee on Drainage, George Ross, chairman; paper, "Forestry in Ontario," E. J. Zavitz, superintendent of Forestry in Ontario; paper, "Concrete Roads," W. A. McLean, chief engineer, Good Roads Department; paper, "Notes on Wawaitan Power Plant," Robert Laird; report of auditors, J. W. Fitzgerald and R. R. Grant.

Evening, 7.30 O'clock.—Dinner at McConkey's restaurant.

THURSDAY, 27th FEBRUARY.

Morning, 10 O'clock.—Report of committee on repository and biography, L. V. Rorke, chairman; report of committee on entertainment, A. T. Ward, chairman.

W. F. STANLEY & COMPANY, LIMITED.

Owing to the continued expansion of business, the W. F. Stanley & Company, Limited, 4 and 5 Great Turnstile, London, W.C., have been compelled to provide for larger office accommodation and will henceforth occupy the premises at 286 High Holborn, retaining their old quarters for export only. All communications to this firm in future should be sent to their new address.

GOOD ROADS EXHIBIT.

The First Good Roads and Construction Exhibition in Canada proved to be more successful than was generally expected. Held in the Dairy Building, Toronto Exhibition Grounds, on Wednesday, Thursday and Friday, 26th, 27th and 28th of February, the Ontario Good Roads Association Exhibit was advantageous to both members in attendance and to exhibitors. The registered attendance at the convention was over three hundred and represented the different cities, towns and counties of Ontario. Some of the papers presented will be published shortly. The following is a list of the exhibitors with names of some of the representatives who were present:

Abram Cement Tool Co., of Windsor, Ont., was represented by Mr. J. D. Abram, who is the inventor of the Abram automatic cement sidewalk tools. The claim made in connection with these tools (finishing trowel, jointer and edger), is that every 20 hours steady use of a full set will save in labor the cost of the tools. The use of these tools was well demonstrated, and they certainly have enough good points to warrant their trial by every contractor who lays cement sidewalks.

Buffalo Pitts Co., of Buffalo, N.Y. This company imported for the occasion a double-cylinder, steel-geared contractor's road locomotive, with several reversible stone spreading cars, which were demonstrated on the roads outside of the building. Also occupied space in the building. This organization presented a good exhibit. The representatives present were Messrs. F. T. Batchellor, B. F. Hoffman and Jas. T. Mack.

Hugh Cameron & Co.—They represented the Waterous Engine Works Co., of Brantford, and exhibited on the road outside the building a Waterous double-cylinder road roller. The exhibit was in charge of Mr. Hugh Cameron. A Buffalo Pitts scarifier was exhibited in their booth.

Canada Cement Co. was well represented by members of the Ontario and Quebec staffs. They exhibited several models of concrete roads. By means, also, of a small lantern, excellent views of roads, bridges, etc., made of concrete were shown. The representatives present were Messrs. Lapierre, Twoey, Dunlop, Cole, Robertson and Wright.

The Canadian Engineer.—This journal had a booth and was ably represented by Mr. P. G. Cherry, circulation manager. Modesty forbids us to mention all our good points. The great thing was, we were there, ready to help, if possible, and still more ready to dispense information of general interest through the columns of our journal for others. Always we are ready to do this, and we trust our readers will bear it in mind.

Corrugated Pipe Co., of Stratford, Ont., represented by Mr. S. R. McConkey, showed samples of their corrugated iron culverts.

Ontario Bridge Co., of Toronto, erectors of bridges, concrete and steel; also showed some photographs of some of the construction work they have undertaken, and exhibited a special type of road dray. Mr. Edgar Price was in charge.

Ontario Government exhibited six models showing the development of the modern type of road construction. The Roman, French, waterbound, macadam and other types were instructively portrayed. Mr. Gray, assistant to the Chief Engineer of Highways of Ontario, had charge of the exhibit.

Ontario Rock Co., of Toronto, exhibited samples of trap rock. The company was represented by the general sales agent, Mr. W. A. Stewart.

Paterson Manufacturing Co., manufacturers of Tarvia Pavements, was represented by Messrs. Smith and Barnett. The claims for "Tarvia" are that it will, in one of its forms or another, solve every Macadam road problem, provide a dustless, cheaply maintained surface, and reduce general road costs. The booth was in a prominent corner and had many visitors.

Rocmac (Ontario) Limited, exhibit was in charge of Messrs. Allen and Seers. Photographs of roads constructed of Rocmac were shown. Many enquiries were received from interested members attending the convention.

Sawyer-Massey Co., of Hamilton, Ont., exhibited their machinery both inside and outside of the building. At the inside exhibit there was shown a stone crusher; outside was demonstrated a Sawyer-Massey steam road roller. This company also manufactures gas tractors, as well as a full line of road-building machinery. Mr. E. Crawford, manager of the good roads machine department, was the representative in charge.

United States Steel Products Co. showed samples of Triangle Mesh concrete reinforcement. The exhibit was in general charge of Messrs. Fred and C. H. Brurcke, the Toronto managers.

Wettlaufer Bros., of Toronto, showed a Wettlaufer traction mixer, with heart-shaped drum, a Mitchell stone crusher and other machinery such as concrete brick-making machinery, etc. This interesting exhibit was in charge of the Wettlaufer brothers and attracted a great deal of attention.

Other companies than those exhibiting were represented at the show. Among them were:

The Barber Asphalt Paving Co., of Philadelphia, represented by Mr. Gordon Smith, of Montreal, and Mr. P. S. Coyne, of Buffalo.

Lecky and Collis, of Napanee, Ont., manufacturers of Napanee rock drills and hoisting engines, and sales agents for Austin cube mixers and trench excavators, Priestman buckets, etc. Mr. Collis represented the company at the show.

The Thew Automatic Shovel Co., of Lorain, Ohio, represented by Mr. H. A. McLaughlin.

The Asphalt and Supply Co., of Montreal, represented by Mr. O. G. Carscallen, the Toronto manager.

The Hagersville Crushed Stone Co., represented by Mr. Robert Hambleton, of Hagersville, the president of the company.

The M. Rumely Co. Inc. of La Porte, Ind., manufacturers of steam and oil tractors and grader attachments.

COAST TO COAST.

Ottawa, Ont.—The revenue of customs receipts for the eleven months ending February 28 was $103,485,000, compared with $17,716,000 for the corresponding eleven months of the last fiscal year. This shows an increase of $25,-769,000 or, in other words, the increase for the eleven months of this fiscal year is greater than the entire customs revenue for the fiscal year 1898-99, which was $25,734,000. The revenue for the month of February was $9,155,000, and for the corresponding month last year $7,447,000, being an increase of $1,707,000.

Port Nelson, B.C.—The cost of surveys of the 420 miles of new road from Le Pas to Port Nelson, which have been made, amounts to $156,430. The construction up to date on McArthur Bros.' contarct has cost $354,830. Supplies, including rails, etc., have cost $105,343, while the bridge over the Saskatchewan at Le Pas was erected at a cost of $108,000.

Ottawa, Ont.—At a recent session of the Senate Senator Chaquette asked for papers relating to the proposed Quebec drydock, which has been under consideration for the past fifteen years without anything definite being done. Senator Power said as there was a great dock in Montreal there did not seem to be justification for the expenditure of a large amount of government money to build another dock so near as the city of Quebec. There would not be enough work for the two docks, and the expense of maintenance would be thrown on the government.

Ottawa, Ont.—The board of control of this city are applying to the Federal Government and also to the governments of Ontario and Quebec to secure the necessary legislation to permit the city to get a supply of water from the lakes of the Gateneau hills. This is the recommendation of the British experts, who estimated the cost to be $7,000,000.

Montreal, P.Q.—The firm of B. J. Coghlin Company, Limited, advise that they are leaving their present offices on St. Paul Street, corner of St. Francois Xavier, on or about the 1st of March, to occupy the new buildings erected next to their factory on Ontario Street East, Montreal. For almost fifty years their name has been associated with St. Paul Street, and while loath to leave a locality where they are well known, increase of business necessitates it.

PERSONAL.

WILLIAM N. ASHPLANT has been appointed city engineer of London, Ont.

MR. W. H. BEMAN, of Montreal, has been appointed commissioner in charge of the street paving for the city of Sherbrooke, Que.

JAMES IRVINE, resident engineer of the Canadian Pacific Railway at Kingston, has been moved to Toronto. L. S. Rudder, of Toronto, will take his place.

MR. PERCIVAL LANCASTER has been appointed city engineer of Belleville, Ont., in succession to James G. Lindsay. Mr. Lancaster commences his duties at once.

JAMES HUTCHEON, ex-city engineer of Guelph, Ont., has accepted a position in the Department of Lands, Forests and Mines at Toronto. He will remain a resident of Guelph for the present year at least.

M. H. BAKER, city engineer of St. Thomas, Ont., has been appointed city engineer of Prince Albert, Sask. It is understood that Mr. Baker will commence his duties in Prince Albert almost immediately.

ALAN FRASER, B.A.Sc., has beeu appointed engineer to the Toronto Iron Works, Toronto. He leaves the office of the district engineer of the Canadian Northern Railway this week to enter into his new duties.

MR. C. H. CUNNINGHAM has just entered into his new position with the Thor Iron Works of Toronto, of which company he is a director. Mr. Cunningham has been associated with Frank Barber, civil engineer, of Toronto, for the past two years.

HUGH GALL, B.A.Sc., has been appointed assistant engineer to Frank Barber, consulting engineer and engineer to the county of York. Mr. Gall will be remembered as having led the Rugby team of the University of Toronto in several of its inter-collegiate and national victories of the last few years.

FRANCIS H. PARR, of the Institution of Municipal and County Engineers, and the Royal Sanitary Institute, has been appointed as permanent engineer for the municipality of Kildonan. He has had ten years engineering experience

in different public works carried on during that time in the suburbs of London. There were about forty applications for the position.

THOS. C. KEEFER, C.M.G., LL.D., of Ottawa, past president of the Canadian Society of Civil Engineers, and also the American Society of Civil Engineers, has been elected honorary member of the Institution of Civil Engineers. Some idea of the extent of the honor conferred may be gained by the fact that there were only twenty honorary members in in 1912, including H.I.M. the Emperor of Germany, H.R.H. the Duke of Connaught, Prince Auguste D'Arenberg, Lord Alverstone, Earl Brassey, Rt. Hon. Joseph Chamberlain, Earl of Cromar, Earl Curzon, Viscount Kitchener, Duke of Northumberland and Lord Strathcona.

COMING MEETINGS.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—A meeting for the purpose of further discussing "Professional Relations," will be held at the Engineers' Club, 32 West 40th St., New York City, Tuesday evening, 8 p.m., March 11, 1913. Secretary, Eugene W. Stern, 103 Park Ave., New York City.

THE CLEVELAND ENGINEERING SOCIETY.—Regular meeting, Chamber of Commerce Bldg., March 11th, 1913. Illustrated Paper on "Storage Batteries," by H. H. Smith, Chief of Research Dept., Edison Storage Battery Co., Orange, N. J. Secretary, David Gaehr.

ILLINOIS WATER SUPPLY ASSOCIATION.—The Fifth Annual Meeting of the Association will be held at the University of Illinois, Campaign-Urbana, Ill., March 11th and 12th, 1913. Secretary, Edward Bartow.

CANADIAN MINING INSTITUTE.—Annual Meeting will be held at Chateau Laurier, Ottawa, March 5th, 6th and 7th. H. Mortimer Lamb, Windsor Hotel, Montreal, Secretary.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memorial Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, P. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

 Contents of this issue on page 435

The Canadian Engineer

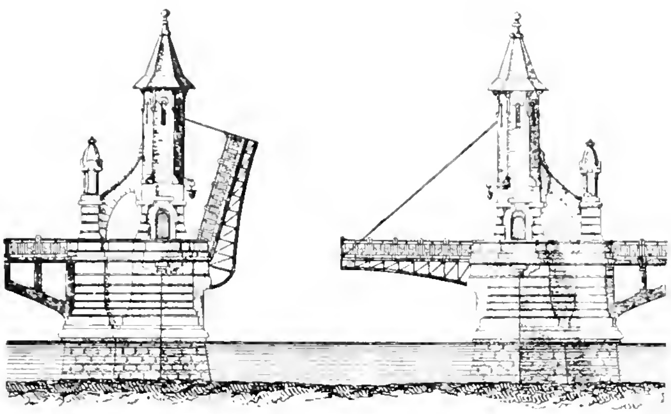
An Engineering Weekly

BASCULE BRIDGES

By H. G. TYRRELL.*

Early French Bascules.—The Belidor system of drawbridges, invented by M. Belidor in 1810, consists of a leaf or platform hinged at one side of the waterway and supported at the outer end by chains or cables passing up over elevated sheaves on the shore structure, either castle wall or tower, and fastened to two separate rolling counterweights, one at each side of the roadway, moving on curved tracks of special form, the outline being called a "sinusoid." The essential idea of the invention is that the centre of gravity of all moving parts, including both leaf and counterweight, travel on a horizontal line. Instead of one large rolling weight at each side, two or more smaller ones connected together may be used.

A modification of the Belidor system was invented prior to 1820 by Captain Délille, who proposed joining the rollers with the outer end of the platform by a bar or stiff member instead of a flexible cable, and working them by an endless chain. When the drawbridge adjoined a building or walled enclosure, vertical grooves for the bars were left in the masonry at each side of the roadway, but, as in the Belidor design, the centre of gravity of all moving parts still travelled horizontally. Equipped in this way, the bridge was very easily worked by hand, and because of its simplicity came rapidly into favor. Exact methods for determining the outline of the "sinusoid" were evolved and the construction henceforth presented no difficulty. The two rolling counterweights were sometimes connected by a shaft or stiff member across the roadway, and in open situations apart from buildings the curved tracks were supported by timber framing.



Bascule in Spain.

A further modification of the methods of Belidor and Délille appeared prior to 1840, the invention of Colonel Bergére. The counterweight in this case described precisely the same curve as in the former methods, but the weight of leaf and balance is supported by a connecting bar or lever mounted at its centre on wheels which roll back and forth on a horizontal track, the principle being similar in this respect to a recent American patent. Another of Colonel Bergére's designs shows the connecting lever mounted on large wheels with their treads at the roadway level instead of smaller wheels on an elevated track.

Mr. J. C. Ardagh, of the Royal Engineers, devised a system somewhat similar to Belidor's, with the platform supported by chains passing over sheaves and connecting at the rear to counterweights which, instead of travelling on a rigid curved track of special form, were guided in their course by other cables, the ends of which were fastened in the proper positions, that the rolling sheaves would describe exactly the same curve as that followed in the Belidor and Délille systems. The bridge was balanced in all positions. Dobenheim's draw was counterweighted with blocks or bars on the chains, the weight being great enough to balance the platform when horizontal, but it was in complete equilibrium in only 3 positions. The Noggerath system was somewhat similar.

An opening span of the Belidor type was incorporated in a design proposed in 1885 by Ordish and Matheson for crossing the Thames at London, and since then several have appeared in America, one of the first being a railroad bridge over the Morris Canal, between Jersey City and Lafayette, completed in 1890. It was all framed in timber and was worked by hand power. The leaf was 25 feet long and the whole draw weighed only 3 tons. Counterweights were 3 feet in diameter.

Another bridge, completed in 1896, to carry four tracks of the Erie Railroad over Berry's Creek, on the Hackensack meadow near Rutherford, N.J., had a span of 32 feet and a clear opening of 24 feet, and at the time was the largest of its kind. It was 44 feet wide between outside girders, and had a total weight of 70 tons. Beside the moving span, it had two fixed plate girders 50 feet long. The counterweights were 6½ feet in diameter, each one weighing 51,000 pounds. They consisted of several circular parts fastened together with bolts, the heads of which at each side were countersunk into the casting. The four railroad tracks were 13 feet apart on centres and were each supported on a pair of deck plate girders. The bridge was operated by hand power by means of 9/16-inch wire ropes passing over 23-inch sheaves.

The longest bridge of the kind and the first important bascule in America was completed in 1897 over the river at Michigan Avenue, Buffalo, N.Y., the span being 153 feet between trunnions and 150 feet between piers. It has two

---

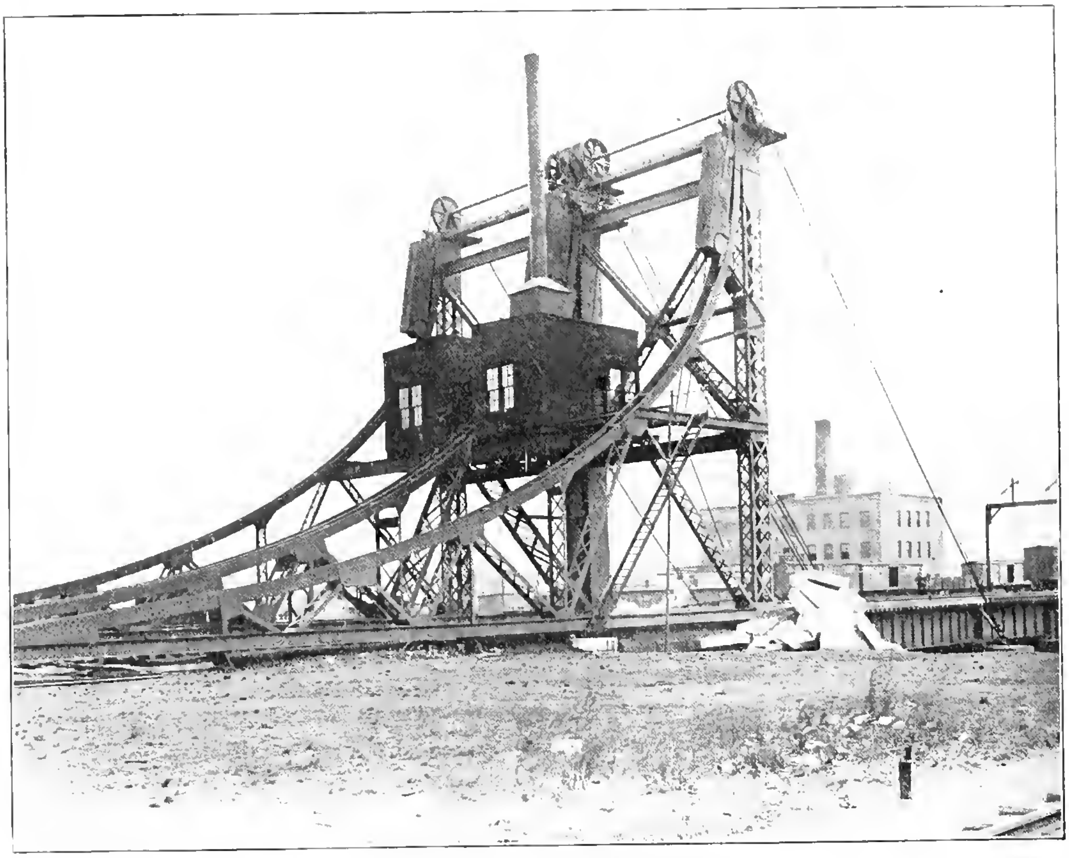
* Consulting Engineer, Evanston, Illinois.

leaves with trusses 77 feet long and 9 feet deep, drawn up by ropes attached to shore towers 77 feet high. Each counterweight consists of ten castings 6½ feet diameter and six others 5½ feet diameter, mounted on a 6-inch shaft 8 feet long. The weights running on double rails are attached to the leaves by four 1½-inch crucible steel cables worked by steam power. At each side of the centre opening is an approach span. The dead weight of each leaf is 60 tons, and the total counterweight at each side is 70 tons. It has a central road 22 feet wide and a 6-foot walk outside each of the trusses. The superstructure cost $38,700, on which there was probably a considerable contractor's loss. It is opened forty to fifty times per day and can be operated by steam power in one minute by means of 6-inch screws 18 feet long, lying horizontally, and attached at one end to the trusses at the upper shore panel point. The screws have three threads ¾ inch square and 4½-inch pitch.

The bridge over the west fork of the south branch of the Chicago River for the Chicago Terminal Transfer Railroad has a clear span of 61 feet, with girders 70 feet long, and was completed in 1899 from plans by George S. Morison. Two ropes and one chain are attached to each of the counterweights, the chains having a rigid hold on the sheaves, while the ropes carry all or most of the load. Provision was made at first for two spans meeting on a centre pier, but the towers and lifting machinery were put in for one span only. The light centre pier gives rigid bearing to the girders and offers less obstruction in the channel than would the centre pier of a swing bridge. Since it was first built the bridge has been raised 4 to 5 feet with new masonry. It has four tracks with sixteen girders 70 feet long and eight girders 27 feet long. The part that is moved is underbalanced in its lower position and overbalanced in its upper position, thus requiring power to start it from either extremity. After its completion, the designer stated that if building another one he would have it underbalanced throughout, and would raise and lower it with a winding engine. The bridge is in two parts, each of which can be operated separately. The sheaves at the tower are six feet in diameter and each counterweight weighs 27 tons.

The Harway Avenue lift over Coney Island Creek, at Brooklyn, was completed in 1898 at a cost of $25,000. The clear span is 50 feet and it is worked by a five-horse-power electric motor, but has also hand power gearings. It is 31 feet wide between railings, and has three main girders 10 feet apart on centres. Each counterweight weighs 45,000 pounds and is supported by 1¾-inch ropes passing over sheaves at the top of towers which are 35 feet high.

A temporary bridge of this type was placed over the Passaic River a few years ago and was built complete in forty days. The clear opening is 40 feet, the hoisting towers being framed of timber, but the girders are of steel. Adjoining it is 280 feet of pile trestle, the total cost of the whole construction being $12,000.



A Belidor Bridge at Chicago.

A patent was recorded on March 4, 1899, in favor of Mr. Montgomery Waddell for a bascule bridge with trusses counterbalanced by weights attached to the upper panel points and rolling on curved tracks similar to the design invented by Belidor, but differing therefrom by having open web truss supports instead of simple beams.

One of the most recent of this type is that completed in 1908 at Tiverton, over Sakonet River. The original design was made by Mr. Augustus Smith, and was revised and approved by Mr. J. R. Worcester. The road is 32 feet wide with a 5-foot cantilever walk on each side, the central way being proportioned for 40-ton electric cars. The opening span is of the Délille system, with two leaves and a clear water width of 100 feet, and at each side of it is a 70-foot girder which supports the counterweight. There are also masonry approaches 581 and 439 feet long, with concrete arches and earth filling between the spandrel walls. The counterweights are rigidly attached by struts to the moving leaves and instead of separate circular rollers, as on the previous design, the counterweight in this case extends clear across the roadway, being mounted at each end on four-wheeled trucks. Motors are connected directly to the track wheels and ropes are not needed. The moving span is without tail pits and all parts are open for inspection. The steel superstructure weighs 430 tons and the total cost of the whole bridge was $250,000.

Tower Bascules With Vertical Moving Counterweights.—Three different methods of counterbalancing draw-bridge leaves were evolved in France during the first part of the eighteenth century by Messrs. Derché and Poncelet.

The Derché System.—In the Derché system, invented by Captain Derché about 1810, chains from the front end of the moving leaf passed over fixed pulleys on shore, and the

counterweights were suspended over spiral sheaves. As the leaf rose and less weight was required to balance it, the spirals revolved to such a position that the counterweights hung over a smaller radius than when the leaf was down. Derché evolved easy methods for determining the exact form of these spirals, and on the spiral axes he placed sprocket wheels with hand chains, by means of which the leaf was operated. Overhead balance levers of the Dutch portal type were also installed in some cases, so the movement could be affected either by chain or lever. Movable hinged struts bracing back diagonally to the abutments, and revolving in against the shore as the platform was lifted, were sometimes placed beneath the leaves. This method of counterbalancing the leaves in all positions was so simple that it became quite popular in France and other parts of Europe.

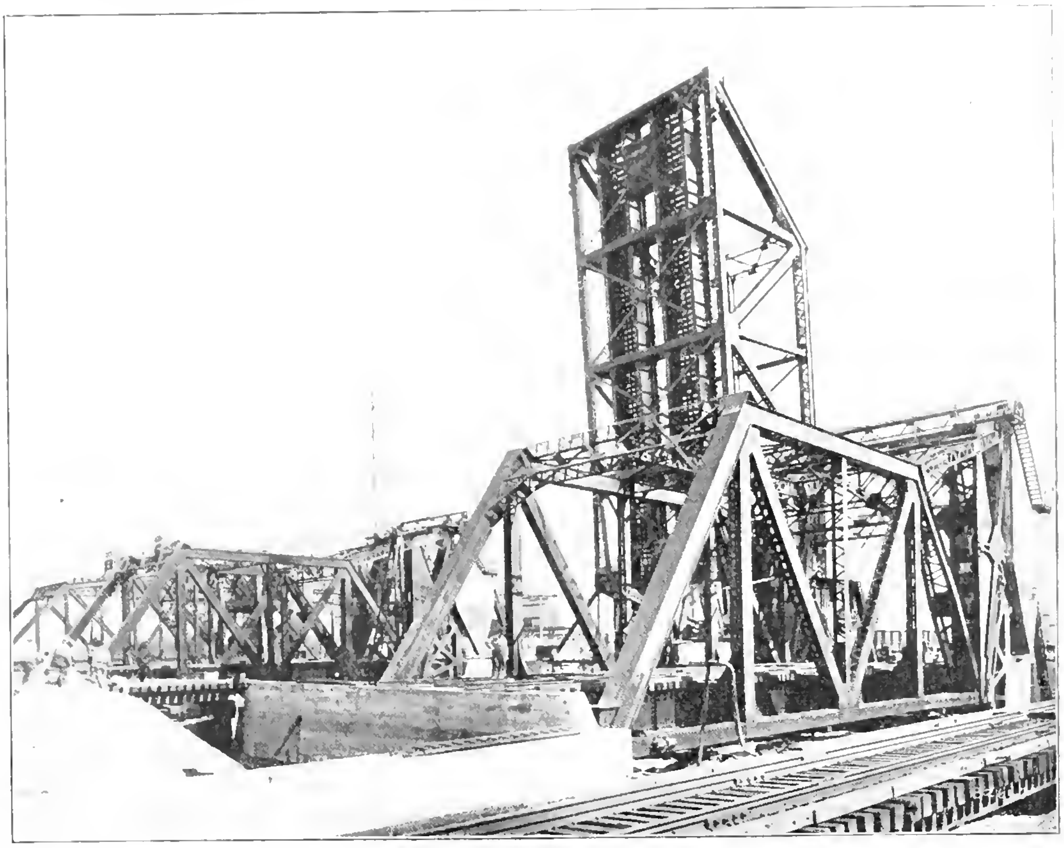
A bridge with varying counterweights had previously been proposed by Colonel Bergére, who intended using weights immersed in water, but his method was not greatly favored.

A modification of the Derché type was used some years ago in San Domingo. At the foot of the shore tower was a conical drum, to the small end of which was attached the balance chain from the outer end of the platform, while to the larger end of the drum was fastened the chain from the counterweight. Two applications of the Derché principle have recently appeared in America, the first of them being proposed in 1901 for the 95th Street bridge at Chicago. The plans showed a double leaf bridge with a clear opening of 140 feet. The leaves act as a three-hinged arch when closed, and are united by centre locks driven by a five-horse-power electric motor. The arch ribs are drawn up by cables passing over two 24-foot drums at the tops of towers, which are 80 feet high, and between these drums and on the same axle are spirals from which the counterweights are suspended. The spiral radius decreases from 12 to 3 feet. The total weight of each leaf is 120 tons.

Another design involving the Derché principle was invented and patented in 1904 by Mr. Wilbur J. Watson. In this design the cables are attached to fixed points on the trusses, and pass around sheaves of the proper diameter to which they are securely fastened, and on which they wind up upon themselves as the bridge rises. The counterweights are carried by chains built up of steel plates and pins. These chains pass around, and are wound from spiral sheaves mounted upon the same shafts as the first-mentioned ones. Chains are used instead of cables for hanging the counterweights because chains can be wound around drums of a smaller diameter. The counterweights are claimed to be less than half of those ordinarily used on bascule bridges, and the stresses in the structure, machinery and foundations are proportionately reduced.

The Poncelet System.—The other two types of bridges with compensating counterweights were invented in France by Poncelet prior to 1840. In one case, the leaves are supported by cables passing over fixed pulleys on shore, and over sheaves behind them, from which counterweights of heavy chain links are suspended, the lower ends of the chains being fastened to the shore structure. As the leaf rises and the chain links descend a greater part of the chain weight is transferred to the lower support, and less to the cables which pass over the sheaves to the bridge. The counterweight is self-acting and extremely simple, and it has, therefore, been extensively used. Small bridges thus equipped can be worked by a sprocket chain and wheel. The principle has been used to some extent in recent moving bridges of other types, as on the Halsted Street vertical lift bridge at Chicago.

A design for counterweight which is a modification of that described above, appeared in 1896 in the competition for a bridge over Newton Creek, the work of J. D. Wilkins and R. W. Creuzbaur. The clear opening of 100 feet was crossed by a single leaf which was drawn up by ropes passing over sheaves on a symmetrical tower on one shore, and it was balanced by a metal box 21 feet long filled with pig iron, and compensated with chain, the whole being described as "the Wilkins system of counterweight." A somewhat similar regulating system was, as previously stated, used on the Halsted Street bridge.



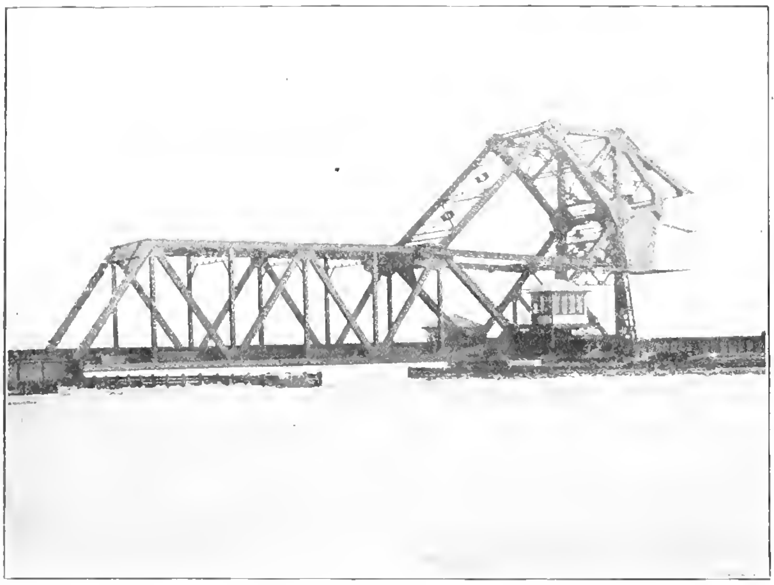
Bridges at Indiana Harbor, Michigan.

Revolving Arch With Bascule Floor.—An unusual design for a bascule bridge appeared at the Newton Creek competition, the work of Mr. W. H. Breithaupt, a Toronto engineer, a patent for which was recorded July 3, 1896. It consisted of movable ribs meeting when closed above the channel centre and forming a three-hinged arch with suspended bascule floor leaves beneath. It was somewhat similar to a bridge previously erected at Liverpool, where the lower bascule leaves are suspended from double swing spans on

each shore, the deck of which is at a higher level. The chief merit of Mr. Breithaupt's design is that, for tugs and small craft the bascule floor only need be raised without opening the arch. The arches and bascule floor had separate counterweights consisting of chains, each link of which weighed two tons.

A patent was granted to Mr. Montgomery Waddell and filed April 6, 1897, for a somewhat similar type of bridge with lenticular or cigar-shaped arch ribs meeting at the centre when closed. The platform, instead of being suspended, as in Mr. Breithaupt's design, was in this case hinged to the arch ribs. Another patent granted to Mr. Waddell at the same time shows double bascule trusses hinged at the foot of the shore towers and supported underneath by diagonal struts bracing back to the abutments.

Suspended Series of Falling Counterweights.—Another system of compensating counterweights was invented by William Burdon and described in the Scientific Canadian of February, 1879. The lifting was accomplished by ropes



Strauss Trunnion Bascule Bridge, Hackensack River, Erie Railroad.

from hydraulic pistons, and the leaves were balanced by cables from their outer end passing over sheaves at the top of shore towers in which a series of weights were suspended, which came to a bearing on the ground as the leaf ascended. A somewhat similar type of small bridge was used many years ago at the Liverpool docks, the chains going down inside the shore columns to the hydraulic machinery below. In 1892, a plan on a larger scale was proposed by Mr. Charles Steiner, of Minneapolis, in which double leaves, each 25 feet long, were used over a 250-foot channel, the leaves being supported by chains passing over pulleys on shore towers and fastened to hydraulic rams. Another bridge at Birkenhead, over the Great Passage at Granaries, carried two tracks of railroad on double leaves over a 30-foot opening. When in their lowered position, the girders were strengthened by hinged struts supported by chains which guided the ends of the struts into sockets on the abutment faces. The bridge was raised by chains passing over pulleys on vertical pillars 10 feet high, set 8½ feet back from the abutment face. It was very light, had no tail end or balance and occupied a very small dock space.

Bridges of this type were brought into active use in America in 1890, when one over the Harlem River was completed for the New York Central Railway, near 135th Street and 4th Avenue. It was designed by Mr. G. H. Thomson, assisted by Mr. J. D. Wilkins. The principle involved is identically the same as that which is so commonly used in crossing gates, which, when open, fold up at each side of the street against their weight cases. The bridge was 106 feet long and 32 feet wide, with four tracks, the two outer ones curving in at the bridge and making it possible for only two trains to cross at one time, notwithstanding the heavy travel of more than five hundred trains daily. Switches were not used. The sheaves at the tower tops were quite unusual, being made of old locomotive driving wheels, 6 feet 10 inches diameter grooved out for the cables. Three years after its completion the bridge was removed and re-erected over the Harlem at Spuyten Duyvil. In 1897 there was a similar one on the Wisconsin Central Railway at Manitowoc, Wis., and another was proposed about the same time by Mr. C. E. Bidell for crossing Newton Creek. The clear opening in the latter case was 150 feet, and towers 112 feet high on each shore support 9-foot drums, over which the cables pass, holding the 65 tons of counterweight in several separate blocks. It was provided with a 36-foot road and 11-foot walks outside the trusses, the whole bridge being supported on cylinder piers. When the leaves were lowered they were to be supported by eye bars from the towers, the bars being hinged at the centre to fold up as the leaf was raised.

One of the last bridges of this kind, completed in 1905, crosses the New Basin Canal at New Orleans. It has an effective span of 70 feet over a 63-foot channel, crossed by through plate girders 9 feet deep, for double track. Towers are 104 feet high, inside of which hang the counterweights in successive blocks weighing 3,000 pounds each. It is operated by a 35-horse-power electric motor, but also has an auxiliary 10-horse-power gasoline engine.

Between the years 1897 and 1900, designs for several bridges of this type were made by I. G. Tyrrell, including those at Elizabeth City, N.C., with a span of 24 feet; Chatham, Mass, with span of 25 feet; Charleston, S.C., with span of 60 feet, and Kennebunk with span of 81 feet. A small one for single track, designed by the writer in December, 1899, had a 21-foot clear opening, and was founded on piles. It was proportioned for light locomotives equal to Cooper's specification E.30, and had hand machinery only. The estimated quantities for superstructure only, without foundation or floor, are:—

Structural steel	20,000 lbs.
Machinery	3,000 lbs.
Counterweight	16,000 lbs.
Total	39,000 lbs.

If the clear opening were increased to 30 feet, the estimated quantities would then be:—

Structural steel	30,000 lbs.
Machinery	3,500 lbs.
Counterweight	24,000 lbs.
Total	57,500 lbs.

A patent was filed February, 1908, in favor of Louis H. Shoemaker, of Sewickley, Pa., for a counterbalanced lift bridge, in which the pull on the cables from the bridge and fixed counterweight is equalized. As the bridge rises, the angle of the cable changes, making a nearly constant pull in the cables from the girders at all times.

Poncelet Bascule System.—This was evolved by M. Poncelet, in France, prior to 1840, and is a modification of the Derché draw. It was revived in 1896 during the Newton

Creek competition by Mr. T. E. Brown, for a double leaf bridge with a clear span of 150 feet. Mr. Brown, four years earlier, submitted a plan for crossing the canal at Duluth, which is said to have been the first important bascule design in America. It had no counterweight, and the estimated cost was $125,000. The towers of the Newton Creek design, standing on each side of the water, were 74 feet high and unsymmetrical, the width of road being 30 feet, with a 9-foot walk outside the trusses at each side, making a total width of 50 feet. The six cables at each side, passing over two 10-foot sheaves made of riveted steel plate, support a permanent counterweight hanging inside the towers, and each span is operated by eight hydraulic rams, the leaves being pushed open by struts connected to the heels of the trusses which swing on trunnions fixed in the tower legs. An unusual feature of the design is, that swinging hinged bents attached to the ends of the leaves gave them a centre bearing under live loads. These bents were to rest on the cast iron caps of submerged piers which could be cleaned of sediment or silt by water pressure from pipes especially laid for this purpose beneath the river bed. Mr. Brown also proposed an alternate plan for disposing of the bents and supporting the leaves by cables from the towers. The estimated cost was:—

Superstructure and machinery	$105,000
Foundations	105,000
Total	$210,000

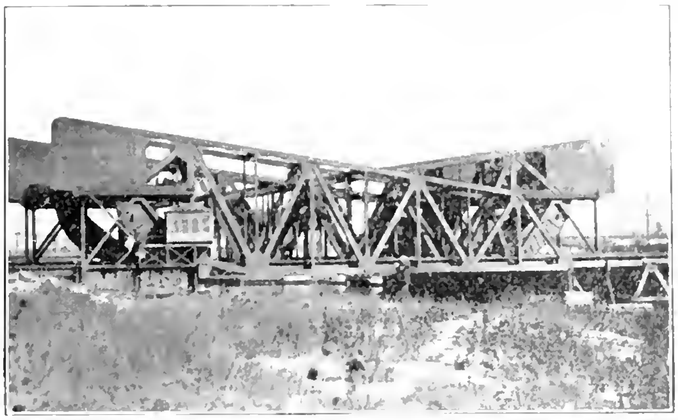
In this design, the tower height could be fixed by the required vertical movement of the counterweight without special reference to the inclination of the lifting cables. But the design with its unsymmetrical towers was complicated. Referring to the various plans which appeared at this time, the Engineering Record, in commenting thereon, rather harshly declared that "the Newton Creek competition has produced an exhibition of more structural ugliness and awkwardness than any other event of its kind in this country." A design somewhat similar to Mr. Brown's was prepared in 1900 for another place, by a structural company in Milwaukee.

The first bridge of the kind completed is at Ohio Street, Buffalo, finished in 1906, with a single leaf 166 feet long and lattice trusses 21 feet deep, over a channel 140 feet wide. One leaf was evidently more economical than two, since it required only one tower, one set of machinery, and one operating house. It replaced an old swing bridge, which was removed when the channel was deepened from 19 to 23 feet. The roadway, 30 feet wide, carries two car tracks, and 7-foot walks project out at each side, making a total width of 44 feet. The span is balanced by twelve plough-steel wire ropes, 2¼-inch diameter, passing over 10-foot cast-steel sheaves (cast in halves) at the top of tower, the two counterweights, each containing 180 tons of cast-iron, moving vertically between guides. The lifting is controlled by hydraulic power from a tank in the tower, under which are girders 52 feet long, and the approach span at the opposite end is 100 feet. Its total cost was:—

Superstructure (including plans and royalties)	$117,700
Foundations	59,300
Total	$177,000

The cables have a heavy bending stress, due to winding over their sheaves, and the breaking load of each one is 190 tons.

The Burel drawbridge, invented prior to 1840, is a modification of that by Poncelet. The counterweight is placed at the extreme end of a 90-degree revolving segment, over which the cables pass when the bridge is in motion. The system has been recently revived and a patent thereon granted February, 1900, to Elmore D. Cummings, of St.



Cambell Avenue Bridge, Chicago.

Paul. It is described as "having a counterweight pivoted to a separate approach framework and connected to the moving leaf by chains which pass under the counterweight framing and over the top chords of the trusses in such a manner that equilibrium is maintained in all positions. The operation is by a rack and pinion on the top chord."

REPORT ON FORESTS.

At the fourth annual meeting of the Commission of Conservation, held at Ottawa January 21st and 22nd, the report of the Committee on Forests was approved, covering recommendations with regard to the following points:

Approving the plan of co-operation in effect between the Board of Railway Commissioners and the Dominion and Provincial Governments for the enforcement of the fire regulations of the board; urging the establishment of a fire-protective service along the Intercolonial and National Transcontinental Railways similar to that provided for in the fire regulations of the Railway Commission; urging the governments of New Brunswick and Nova Scotia to organize separate branches devoted especially to forest fire work and to appoint technically educated provincial foresters as has been done in British Columbia, Ontario, and Quebec; calling attention to the necessity of considering the requirements of brush disposal in the issuance of new licenses and the renewal of old licenses by Dominion and Provincial Governments; approving the organization of co-operative associations of limit holders and the principle of contribution by the Dominion of Provincial Government in proportion to the benefits received; urging the Dominion and Provincial Governments to begin a systematic study of the extent and character of forest resources; emphasizing the necessity for the collection of complete fire statistics; approving co-operation with the government of Ontario in an examination of forest conditions west of Sudbury and south of the Clay Belt; approving the proposed extension of the Dominion Forest Reserves and the establishment of a game preserve in the southern portion of the Rocky Mountains Forest Reserve and in southeastern British Columbia adjoining the Glacier National Park; urging that all appointments in the forest services of the Dominion and Provincial Governments should be based solely on capability and experience; urging the government of Ontario to undertake a systematic classification in the Clay Belt in advance of settlement to the end that settlement may be properly directed, and that non-agricultural lands may be reserved from settlement and entry.

REPAIR AND MAINTENANCE OF ROADS.*

By Dr. L. I. Hewes.†

The primary defect in road repair and maintenance to-day is lack of business management. The management of road construction is slowly improving, but repair and maintenance continue neglected. There is a certain enthusiasm and interest about new work which is entirely lacking for repair and maintenance operations. It is now well recognized, however, that no system of roads will remain a good system unless continuously cared for.

It is necessary to distinguish between repair and maintenance. When a road is finished, traffic and the elements act continuously to deteriorate it, and will ultimately destroy it. To oppose such deterioration, maintenance equally continuous is required. If maintenance is neglected the best roads will very soon require repair and longer neglect will even require reconstruction. It has been customary for a long time to classify repair as maintenance. It is a natural mistake in view of the fact that, generally speaking, roads on this continent have not been continuously maintained and therefore if maintenance is referred to, it necessarily signifies repair.

Under the organization which prevails throughout Canada and the United States, town and county roads are largely in charge of local officials elected at short intervals. Road management constitutes, as a rule, only a part of a miscellaneous list of duties. Consequently local officials are not elected because of their skill in road making. The typical road official has abundant confidence in his ability and usually proceeds to try out his ideas at the expense of the community. He has his own definition of gravel, crown, grade, etc., and usually has spent considerable money before he is willing to seek advice; and then it is time for electing a new man. Now, any system in business where an executive officer was dismissed as fast as he learned his duties would be unhesitatingly condemned. Why do we continue to use such a system on our highways.

The difficulty is largely because the local civil unit for highway purposes is too small. Too small because the annual appropriations for highways do not warrant the employment of skilled supervision; too small because with the permanent practice of rotation in office the annual appropriation is handled by each official as *his* appropriation, without reference to what has preceded or what is to follow. Too small because the experience in road construction and maintenance does not cover a wide enough range to supply information which already exists beyond the borders of the local community. The remedy for this condition, which so universally prevails, is co-operation in some of its various forms. A possible form of co-operation is for townships to collectively organize road districts and hire a salaried road engineer. Another possible form is to delegate more authority over local roads to county officials and to require a high-class county engineer. A still more effective form is to invite co-operation from the state or province, even in the matters of township roads, as well as in county roads and inter-county roads. It has been done in the State of New York.

You will observe that all of these methods suggested involve more centralization in the matter of roads. If there is objection to such centralization, the answer must be that there must then continue a "road problem," for an actual study of the scant records that have been kept on the cost and method of earth road work always reveals the startling fact that enormous sums of money have already been spent under the old system without visible improvement in the roads. I do not hesitate to condemn the use of statute labor upon highways. It has never proved effective. There are several fundamental objections to its use. First, under the statute labor system, work upon the roads cannot be, in any sense, continuous. Neither can it be applied "in point of time." Second, the attitude of freemen toward such work is careless and indifferent, and the days of working out the taxes are too often regarded as more or less of a jollification period. Statute labor is not economy even for those who advocate is strongly. For those who advocate it strongly are the residents who see in the custom an opportunity to avoid cash payments and to discharge a duty to the community with a minimum of effort. Now, the dwellers along the road are the ones to use the roads, and in proportion as the repair and maintenance of their roads is poor, so is the transportation burden per ton mile of useful produce increased. Those who advocate statute labor in preference to cash taxes simply shift the payment of a road tax to the payment of a mud tax. The road tax is a definite sum of cash, the mud tax has the never-ending invisible burden on the cost of hauling.

Let us consider, then, the repair and maintenance of a typical well organized county road system. In the first place, there should be a map of the county showing plainly all the roads within its borders. These roads should be classified. A possible classification is market roads, through roads and neighborhood roads. Necessarily many market roads will also be through roads and usually every through road is in part a market road. When the roads have been classified according to their service, there should be indicated the nature of construction on the already improved portions in each class. By consulting records, the average annual appropriations for all road and bridge purposes for a series of years may be determined. It will usually be found that some of this money has been spent for the new work, but that a large percentage of it must go for annual repairs. The county highway engineer or other highway engineer in charge of the road system must then adopt a financial plan, not for one or two years, but such a plan as will, within a series of years, result in a general betterment of the highways under his jurisdiction. A certain large percentage of the roads will receive a minimum of expenditure proportioned according to their importance. These roads will, many of them, be neighborhood roads which serve, in many instances, but one or two families. A plan of improvement system established for all improved roads and especially for the important roads which must wait for improvement.

The order of improvement to the relatively small percentage of most used roads should be definitely determined, and the type of improvement should be carefully planned. In making such plans, it must be understood that the first mile of any highway radiating from a market centre receives an annual traffic many times greater than a mile of the same road which is six or seven miles away from the market. Therefore, the type of improved surface adopted near the town must necessarily be more expensive than that adopted on the outlying mileage. A great deal of permanent improvement may be brought about on earth roads by the expenditure of the money which is usually classified under annual repairs. The engineer should first determine the existing profile of such roads and establish a grade line toward which some work may be done each season. The necessary improvement of the culverts, such as replacing wooden and other cheap construction by more durable construction such as concrete, should be planned so that some permanent

* Paper presented to Ontario Good Roads Association meeting, Toronto, February, 1913.

† Director, Maintenance Division, U.S. Office of Public Roads, Washington, D.C.

piece of work may be done each year and the whole effort should be to produce ultimately a road which may be adapted to this service, and which shall require low annual repair and maintenance charge. You must see that no such scheme of work can be planned and carried out by any road official who sees only the expenditures of one year ahead.

To get a little nearer to details, there must be begun a systematic set of highway accounts. All operations of repair and maintenance, as well as construction, should be classified as grading, ditching, repairing culverts, dragging, etc., and the unit costs of the various items must be obtainable from the records. To accomplish such a result, distributing tables may be printed on the backs of warrants and vouchers for labor paid. A great defect in maintenance and in repair has been the unintelligent management of materials and machinery. If a macadam road is to be maintained, there must be a supply of No. 2 stone stacked in considerable quantity at intervals along the road. The hauling of this material should be done at the most economical season of the year, and it should be continuously available for small repairs. The same applies to gravel. A great many roads may be constructed successfully and maintained as gravel roads with good results. For this purpose the location of the sources of supply of gravel and gravel pits should be plotted on the road map and a record of the quantity in each pit kept. Very frequently gravel is hauled necessarily great distances for various insufficient reasons. Too often the owner of the gravel pit is also managing some of the roads and may prefer to haul a mile or two from his pit when there exists a supply of good gravel within a quarter of a mile of his job. There is frequently, however, good gravel handy to work, but which has never been discovered or developed. It will pay to make a most careful investigation of the source of gravel supply along every road.

With reference to the repair of earth roads, the custom of scraping sod and refuse of all kinds into the road centre with a scraping grader cannot be too severely condemned. It is a universal cause of bad roads and waste of highway funds. In repairing an earth road with a scraping grader, the sod may first be scraped off and carted away or the sod may be raked off or picked out with forks and carted away, but never should sod or rotten leaves or manure or any organic substance be placed on the road. The operations of the road grader have been positively damaging in some cases. Many country roads have gutters that are too far from the travelled way and the road supervisor runs the scraping grader a little outside of the wheel tracks to form a new gutter which wanders in and out and up and down and has no outlet. The cost of operating a scraping grader with from two to eight horses attached is very great, and unless very effectively managed is a source of tremendous waste. Where new gutters must be formed, lines must be run before work is commenced, and broad shallow outlets should be constructed through the turf at all low points and all intermediate points on hillsides. Frequently the repair operations with a road grader can best be accomplished by scraping old material off the road toward the gutter and carting it entirely away. A great defect in most country roads is a high shoulder just outside the wheel track. The road grader can be used effectively to lower the shoulder by beginning at the wheel track and working in successive trips toward the gutter. The earth can then be moved to the centre of the road more quickly and without moving a constantly increasing mass. Very frequently the blade of the road scraper is run too deep at the gutter and not deep enough upon the shoulder.

When an earth road has been put in repair, it can be maintained by the road drag. The original form of the road drag was a split-log drag made from the split halves of a six to eight-foot log, six to eight inches in diameter. The two halves of the log are placed face forward and are set two and a half feet apart and at an angle of 45 degrees to the axis of the road. They are suitably braced and supplied with double-trees. In using the split-log drag, two horses are usually needed. Dragging begins at the outside edge or the gutter line of the earth road and proceeds toward the centre. The effect of the drag is to pair off ruts and move a small quantity of earth toward the centre of the road. It also has the capacity to puddle the surface material and form more or less impervious layers which prevent moisture from soaking into the roadbed. To drag a road twenty-four feet wide will require three round trips. A team of horses can draw a drag in ten hours about twenty-four miles, so that with three round trips, about four miles of road can be dragged in a day. This is probably the maximum. On steep grades or with unfavorable conditions, such as irregular gutters or stones in the road, the performance will be less. The minimum cost, figured on a four-mile basis, depends on the price of a man and team; at $4 a day, a complete dragging for three round trips is $1 per mile. In the experimental work by the United States Office of Public Roads in Alexandria County, Virginia, the cost of dragging has been about $1.25 per mile of three round trips.

The first year of dragging an earth road will require a greater number of trips than in subsequent years. Possibly 24 draggings will be required. As the road gets harder under continued dragging and traffic, fewer trips are needed. Important problems to determine immediately are how to establish the dragging system. Probably the best way will be, for the present, for road officials to contract with men who live along roads to drag sections from two to four miles in length. The dragging should be done after every rain and the section men may be required to fill out and forward to the supervisor a post card for each day of dragging. As time goes on, it may be possible for many communities to combine the road patrol and dragging system. This will require the continuous employment of men for probably seven months in the year. If they are paid $45 per month with the understanding that they are to do all dragging, when necessary, the annual cost will be $31.50 per mile on a ten-mile section. This is not an excessive cost per mile. It would no doubt pay to establish such a system in those counties which are spending around $40 per mile on any considerable mileage in the community. The presence of the patrolman during storms to prevent erosion and keep drainage in working order is a great permanent benefit to the road. In the experiment by the United States Office of Public Roads, as above referred to, about 43 per cent. of the patrolman's time was devoted to repairing, cleaning and improving ditches and under-drains and 23 per cent. to dragging. Whatever system of dragging or continuous maintenance is adopted, and the continuous maintenance is the best system, there must be competent inspection and daily reports to the inspector.

On the continent of Europe, the road men are frequently supplied with written instructions covering the slightest detail of their work. There is no reason why such a system could not be adopted on this continent. There is need for written instructions covering a great variety of details; for example, the care of the road at driveway entrances, particularly on hill-sides, is extremely imperative to prevent wash from adjacent lands. This is also true of road intersections.

With reference to the method of maintenance of macadam, gravel and bituminous macadam roads, there is much to be said. Written instructions should be issued covering all such points as the selection of stone, the preparation of worn holes and ruts to receive repair material, sweeping, scouring and picking up of the old road, etc. Wherever a

roller is present there should be instructions to roll all macadam roads in the spring as soon as the frost is out. The management of the hauling of gravel and broken stone, the balancing of men and teams, offers a great opportunity for economy and detailed instructions on such matters are not superfluous.

It is scarcely necessary to add to what has been said above that the repair and maintenance of our highways is a business which requires trained men for its management and skilled workmen for its performance. There is no need to argue and waste oratory over the road question longer. We know it needs business management and we know that it costs an excessive amount of money under the old system. Furthermore, we know that the roads do continue poor. Happily, it has been found that all road work responds amazingly to organization and skilled supervision, nor is it necessary for a general election or overhauling of official positions to make a beginning in the improvement of repair and maintenance operations upon our highways.

FIRE CLAY TESTS.*

The term "fire clay" as it is generally interpreted has a very indefinite and elastic meaning. Usually it is applied to any clay which may be made up into wares that will withstand high temperature. This might mean any degree of heat from that attained in an open fire-place to that reached in a furnace for ore smelting. Obviously a clay suitable under the first set of conditions would not, in all probabilities, be suitable under the second. Fire-clays are frequently found associated with coal seams and in consequence miners invariably call any clay so associated a fire clay. In general this is far from the truth. The clay worker, at least, must have a more definite conception of the meaning of the term.

It is commonly accepted that the dividing line between refractory and non-refractory clays, as regards their temperatures of fusion, lies at or near 1,650 degrees centigrade, although this cannot be taken as a safe criterion for classifying refractories. It can be safely said, however, that very few No. 1 fire brick are made from clays fusing below this point. Since a high tension fusion point is the prime essential, its determination might well be made the first preliminary test.

The clay to be tested is moulded into a small "trial" the size and shape of a Seger cone (a tetrahedron or triangular pyramid about two inches high and measuring about half an inch at the base. This is placed in a vertical position on a fireclay slab, lowered into a suitable furnace, and the temperature gradually raised until fusion has proceeded to such an extent that the sharp edges of the cone have assumed a rounded appearance and the tip has fallen over until it touches the base. The temperature at this point is recorded as the temperature of fusion.

At first this might appear as a very reliable index to the character of a clay, but upon carefully considering the facts this is found not to be the case. Clays, being mixtures of minerals rather than definite chemical compounds, have no well defined melting points. The change from the solid to the viscous state is very gradual, often extending over a period of several hundred degrees. If two clays are taken whose cones show the same temperature of fusion, it may occur that if an appreciable load be applied to each at temperatures approaching their fusion points, great difference will be noted in their failure temperatures. This is due to the difference in their periods of softening; the one having the longer softening period failing first.

To this end, a test of fire brick under load at high temperatures has been devised by Bleininger and Brown at the Pittsburg Testing Laboratory. The furnace used for this work was of special design and is described by them in detail in Vol. XII, transactions A. C. S. It is fired by means of natural gas and compressed air and it is possible to bring the temperature up to 1,350 degrees Centigrade in about five hours. The load is applied to the brick by a lever outside the furnace and is carried to the brick through a high-grade fire clay bar acting as a column. The lever is fitted with adjusting bolts by means of which it can at all times be kept in a horizontal position. The movement of the lever can be observed by the operator and is an index to the action of the brick under test. Their final recommendation is that the brick be placed on end under a load of 50 pounds per sq. in., and subjected to a temperature of 1,350 degrees Centigrade for one hour. They further recommend that a one-pound fire brick should show no other marked deformation than a shortening of not to exceed one inch in the total original length of nine inches.

Some objections might be raised to this test on the ground that the time factor at high temperature figures prominently in the failure of fire brick and that in this case the specimen is held at the maximum temperature for only one hour. On the whole, however, the test relatively approximates actual conditions of use and gives such consistent results that it is likely to become, in time, a standard test for fire brick.

The furnace used for making the actual fusions are of several different types. The "Carbon Resistance Furnace" is probably the most convenient and satisfactory of those in use. It is described by Coggeshall and Bleininger in Vol. X. Trans. A. C. S. The casing is made from a high-grade fire clay and is supported on a wrought iron plate. A wrought iron ring and the crucible complete the list of parts. An annular space between the crucible and casing is packed with carbon; a grade known commercially as "Electric Furnace Carbon." The electrical connections are made through a supporting plate below and a ring above. The heat is generated by the resistance of the carbon to the flow of current. The current from the power line is stepped down through a suitable transformer so that it is available at five volt intervals from twenty to seventy volts. With this apparatus it is possible to get sufficiently high temperatures to fuse almost any clay. With the one in use in the Ceramics Laboratory of the Iowa State College, temperatures of over 3,200 degrees Fahr. have been obtained and this limit was determined only by the failure of the crucible by melting.

Methods for the testing of fire clays and fire clay products have not yet been standardized but considering the progress that is being made in Ceramics work, it should not be long before methods for systematic examination are available.

* From the Iowa Engineer, by M. F. Beecher, B.S., assistant in Ceramics, Engineering Experiment Station, Ames, Iowa.

DOMINION STEEL CORPORATION.

The nail plant of the Dominion Steel Corporation at Sydney is being steadily enlarged and although the company has been making nails on a commercial scale only a few months it is already becoming a large factor in the market.

A galvanizing plant of modern type is in operation. The only thing needed to complete it is the installation of the permanent power

The company's wire mill is equipped not only to provide wire for the nail mill and galvanizing plant, but wire for sale as well, including wire already drawn to be made into nails. The new annealing department to supply that part of the wire market is being rapidly pushed forward to completion.

WATER FRICTION IN WROUGHT IRON PIPE.*

Due to widely varying tables that appear in different handbooks and the necessity of elaborate interpolation to make them usable, a great deal of time is generally wasted in solving problems in which friction of water in pipes is a factor. Ira N. Evans (Power, July 9, 1912), has taken six of the best formulas for the friction of water in commercial wrought-iron pipe, together with the results of several tests, and compared them in tabular form.

The following were the principal formulas used by Mr. Evans in obtaining his average:

(1) Williams & Hazen formula:

$$V = cr^{0.63} \left(\frac{h}{l}\right)^{0.54} 0.001^{-0.04}$$

V = Velocity in feet per second;
c = Constant varying with condition of the pipe;
r = Hydraulic radius = $\frac{d}{4}$ in feet;
h = Friction head;
l = Length of pipe in feet.

The constant 120 gave results for most of the sizes higher than the average, while the factor 125 would give results checking closely with the average.

(2) Darcy's formula:

$$h = 0.003732\ l\ V^2 \frac{D + 1}{D^2}$$

D = Diameter in inches.

This formula gives values higher than the average.

(3) Meier's formula:

$$h = 0.0038\ l \frac{V^{1.86}}{D^{1.25}}$$

D = Diameter in feet.

(4) Harrison's formula:

$$h = 0.00375\ l \frac{V^2}{D}$$

D = Diameter in inches.

The results from this formula are below the average for pipe up to 6 in. in diameter.

(5) Fanning's formula:

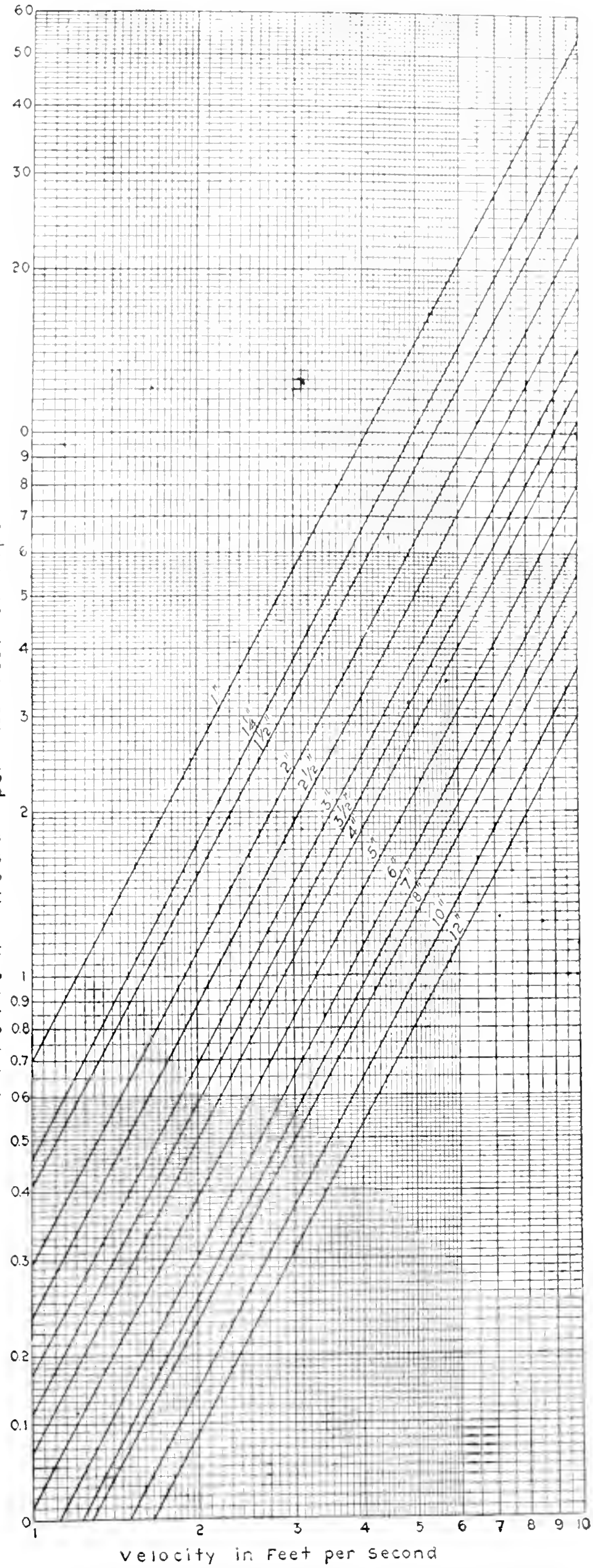
$$h = f \frac{l\ V^2}{d\ 2\ g}$$

The constant f varies for each change in size and velocity. This formula follows the average closely and gives results more consistent than the others except that of Williams & Hazen.

(6) Serginsky's formula, compiled from the latest German authorities, was also used. It gives results above the average for small sizes and below the average for large sizes.

The average values derived by Mr. Evans, mainly by the foregoing formulas, have been plotted by W. L. Durand, on logarithmic paper, as shown in the accompanying curves (Power, Oct. 29, 1912). All equations of the general form $y = B x^n$ will plot at straight lines. Several of the formulas are

* Taken from Engineering and Mining Journal, Vol. 94, No. 23.



FRICTION HEAD IN PIPES 1 TO 12 IN. IN DIAMETER

of this form, and those that are not vary from a straight line to only a slight extent. The average values then may safely be represented by a straight line, as the greatest variation will be much less than the difference between any two values that make up the average.

The method of using these curves is self-evident, there being three variables and in any problem containing two of them the third can be found immediately from the chart. If only one variable is known, several values of one of the other two may be assumed and the corresponding values of the third found from the chart. The values that seem to best fit the problem may then be chosen.

The chart is plotted with velocities from 1 to 10 ft. per sec. as abscissas and friction head per 100 ft. from 0.1 ft. to 100 ft. as ordinates. Each curve is for a definite pipe size as indicated, and with a little variation, all the way through for velocities of 1 ft. per sec., the chart shows values practically identical with the averages in Mr. Evans' table.

For example, take a 3-in. pipe with a velocity of flow of 6 ft. per sec., the friction head per 100 ft. of pipe would be 5.45 ft. To produce a drop in head of 2 ft. in 100 ft. of 5-in. pipe would require a velocity of 4.7 per second.

ROAD CONSTRUCTION COURSE AT UNIVERSITY OF TORONTO.*

By A. T. Laing, B.A.Sc.†

Mr. Chairman,—I appreciate very highly the time given on your programme in order to make a statement regarding the attitude of the University toward the movement for better roads, and to tell you of what we are attempting in the way of training men for the duties and responsibilities of highway engineers.

For some years Dean Galbraith, who has given practically his whole life to the training of young men to meet the varied needs and ever increasing demands of this rapidly developing country, has felt that something special should be done to promote this important branch of engineering, and I am glad to be able to tell you that a beginning has been made.

That a technical course of instruction is of great importance in this connection must be admitted by all. There is perhaps no line of engineering work in which the demands are so varied and which require a wider range of knowledge and experience. Called upon as the highway engineer is to deal with constantly changing physical conditions and a varied supply of materials of construction, it is highly important that he should be thoroughly familiar with the fundamental sciences and their application.

He should know how to make surveys, plans and profiles,

Hydraulics.
Strength of materials.
Machinery.
Bridge design.
Masonry and concrete.
Geology.
Chemistry.
Structure of earth crest.
Laboratory methods.
Interpretation of reports.

*Address to Ontario Good Roads Association held Feb. 27th, 1913.

†Secretary University of Toronto.

Now, it is not the intention to establish a four-year course in highway engineering, but to make it a part of the final year in civil engineering. We have started by giving a lecture course in roads, pavements, maintenance, construction, and a laboratory course in the examination of materials, both in road metals and bituminous materials. But we do not expect by this means alone to turn out highway engineers. Superadded to all the instruction that can be given must be a wide experience, and here is where, I trust, this Association and the University may be able to co-operate.

DEFECTIVE CULVERT RECONSTRUCTION.*

By Mr. W. H. Mills.

A defective culvert at Killyman, on the Great Northern Railway, Ireland, was about 160 feet long and was surmounted by an embankment 50 feet in height. It was properly placed in the lowest point in a ravine, and afforded the only outlet for streams and surface water which gathers on the higher side of the railroad.

After carefully considering the many difficulties which arose, a cast-iron tubular culvert was decided on, the system being somewhat similar to the "Two Penny Tube" in London, only it was cut through compact earth, whereas in the Killyman tube the excavation was through loose ground of a railway embankment 50 feet high, consisting of tipped clay, boulders, roots of trees, etc.

The cast-iron tubular culvert was circular in section, with an internal diameter of 10 feet, the outer shell being 1⅛ inches in thickness. There were 91 rings, making a total length of 159 feet 3 inches. Each ring was 1 foot 9 inches wide, and consisted of six large segments, and one small segment, or key-piece, 10 inches long, at the top. These segments were all bolted together with ⅞-inch bolts and washers, placed at about 9-inch centres in the vertical direction, and at about 6½-inch centres in the horizontal direction. All butting surfaces of the castings, both vertical and horizontal, were machined perfectly true, and were thickly coated with white lead as they were bolted together during the progress of the work. To guard against any compression at the crown, which might be caused by the loose or made ground of the embankment overhead, transverse tie rods, ⅞-inch in diameter, and about 7 feet 5 inches long, were bolted to the upper joints of every third ring.

When the 159 feet 3 inches length of cast-iron tube was fixed in position, and bolted together, the lower half of the circumference was lined for the entire length with a half brick (4½ inches) lining of hard brick laid in cement. For 7 feet in length at each end of the culvert the half brick lining was continued all round the inside circumference. A strong masonry face wall and wing walls were built at each end, with large pitching stone invert between the wing walls.

It is interesting to note the comparison of weights. The cast-iron culvert, when taken full of water, weighs 137 tons less than the mass of earthwork which it replaced, and so, instead of an increased weight on the soft surface ground, there is a very considerable diminution. And we must also remember that the culvert, which weighs 511 tons when at its fullest capacity, is never more than one-third full when in its normal condition.

The total cost of the work was $8,500, and proved a perfect success, as work was carried on without hampering the railroad schedule in the least.

*Given in an address before the Institute of Civil Engineers, Ireland.

REPORT TO CITY OF OTTAWA ON SOURCE OF WATER SUPPLY.

The city of Ottawa lately engaged Sir Alexander Binnie and Dr. C. A. Houston as the most capable experts on water supply in Great Britain, to examine into and report to the city on a suitable water supply. The preliminary report of these engineers has lately come to hand and is published herewith. A feature of the report, outside their condemnation of the Ottawa River as the best source of supply, is their calculation that about seventy-five per cent. of the water at present pumped for the city is wasted.

"1. The Ottawa River, in our opinion, is unfit for domestic use in its present unpurified state. Moving the intake higher up the river might improve matters, but would not alter our settled conviction that this source of supply is unsafe in the absence of an approved process of purification. We are convinced that the up-river population is likely to increase rather than to decrease and despite all arguments to the contrary, we remain unconvinced that any rules and regulations can so control pollution in the future as to render the Ottawa River safe for domestic use in its unpurified state. To eliminate the chief risks of these pollutions would entail the construction of intercepting sewers on both banks of the river for many miles above the town at an enormous cost, nor would the fulfilment of this project completely remove our objections to this source of supply.

Must Use Chemicals.

"2. Apart from its liability to sudden accidental pollution of a specific sort, the Ottawa River water is highly colored and it would be a physical impossibility to render such a supply satisfactory without the aid of chemicals. Apart from the merits of the question we recognize that the use of chemicals is repugnant to a large proportion of the citizens of Ottawa.

Waste of Water.

"3. Our difficulties in pronouncing on a permanent source of supply have been greatly increased owing to the apparent consumption of water per head of the population being vastly in excess of all reasonable requirements. The system of distribution obviously requires a thorough investigation and the gross wastage of water not attributable to the consumer should receive immediate attention. At present the wastage would appear to amount to 75 per cent. of the total quantity pumped. In addition, we are strongly of the opinion that the climatic or other local conditions afford an insufficient excuse for any reckless waste of water on the part of consumers. It is essential to recognize that the supply of water per head of the population, hugely in excess of actual requirements, may involve the rejection on financial grounds of new schemes of water supply which otherwise appear to be eminently well suited for the needs of the city.

Lake Water Sources.

"4. In considering schemes for a permanent supply we have ruled out unpurified river water altogether and have contrasted the lake sources of supply with Ottawa River water after efficient purification.

"5. We have arrived at the conclusion that there is a bountiful supply of clear and wholesome lake water available for the needs of Ottawa for many years to come.

"6. Subject to the engineering difficulties of bringing lake water to Ottawa not proving financially too onerous a burden to be borne, and assuming that the drainage area chosen for the purpose would be protected from all sources of human pollution. We have finally decided to recommend the ultimate abandonment of the Ottawa River as a source of supply and to advocate the choice of a virgin lake water.

"7. It is absolutely impossible for us at this stage to discuss ways and means or the precise localization of the northern lake or lakes at present contemplated for water works use and so we have contented ourselves with dealing with general principles. We propose, however, to institute such further inquiries as will enable us to make specific recommendations as soon as is reasonably practicable.

"8. We consider that the present is a golden opportunity for securing for the Capital of the Dominion an unimpeachable source of water supply and of providing for the city without any form of treatment a water neither too hard nor unduly soft and of a bright, clear and transparent appearance.

Temporary Precautions.

"9. Until this great work can be accomplished it is necessary to adopt certain remedial measures and we suggest:—

"(a) That the water in the pipe line between the intake and pumping station should be kept uniformly under pressure.

"(b) That a sedimentation basin should be constructed at a cost which we estimate should not exceed $17,000 by connecting the piers at the intake with the high land on Lemieux Island.

"(c) That the double chlorination treatment now in operation should be stopped and a single treatment of the water as it enters the basin substituted for it. This, in our opinion, would enable the present dose to be reduced or, if the same dose were retained, the treatment would be rendered much more satisfactory than is the case at present.

"(d) That steps should at once be taken to reduce the extravagant rate of consumption per head of the population.

"10. We desire to point out that it is not our function to deal with health matters in the city, but it is obvious that provision of a pure water supply is only one of the steps necessary to secure the safety of the people of Ottawa from undue incidence of preventable diseases.

"In conclusion, we desire to place on record our appreciation of the courteous manner in which the mayor, his colleagues and various officers of the corporation have assisted us in our investigation. (Signed) ALEX. R. BINNIE, A. C. HOUSTON.

"February 10, 1913.

ONTARIO'S PIG IRON PRODUCTION

Ontario's iron and steel industries have received considerable attention since the intention of the United States Steel Corporation to build a plant to cost $20,000,000 at Sandwich, Ontario, was made public. It is probable that the corporation will erect a number of blast furnaces in addition to wire, rail, structural and bar mills.

At present there are nine blast furnaces in Ontario for the production of pig iron. The Algoma Steel Company, at Sault Ste. Marie, has three, the Canada Iron Corporation, Midland, two; the Steel Company of Canada, Hamilton, two, and the Atikokan Iron Company, Port Arthur, and the Standard Chemical Company, Deseronto, one each, reports Mr. T. W. Gibson, deputy minister of mines in the 21st annual report of the bureau of mines. In all, these plants turned out 526,610 tons of pig iron, valued at $7,716,314, an average of $14.65 per ton.

Much the greater part of the steel output of the Algoma Steel Company is rolled into "standard tee" rails, of which the production last year was 243,703 tons, the remainder, 24,617 tons, being in the form of merchant bars, tie plates, angle splice bars, light rails, bolts and nuts.

RAILWAY STATISTICS.

Statistics of steam railways, prepared by the Deputy Minister of Railways and Canals, have lately come to hand and are published below.

Railway Capital.

During the year ended June 30th last, $21,251,664 was added to the stock liability of railways, and $38,996,661 on account of funded debt—representing a total addition of $60,248,325. This increase over 1911 brought the total capital liability up to $1,588,937,526.

The facts with respect to capital liability in 1911 and 1912, for purposes of comparison, are as follows:—

Capital.	1911.	1912.	Increase.
Stocks	$ 749,207,687	$ 770,459,351	$21,251,664
Funded debt	779,481,514	818,478,175	38,996,661
Total	$1,528,689,201	$1,588,937,526	$60,248,325

It will be observed that, with double the operating mileage added in 1912, the amount of capital liability was slightly more than half the increase for 1911. This is explained by (1) market conditions, and (2) the issue of stocks and bonds prior to the completion of line mileage. In other words, the obligation is incurred before track mileage can be officially recorded.

The funded debt of railways was, in 1910, 1911 and 1912, distributed under the following heads:—

Funded debt.	1910.	1911.	1912.
Bonds	$696,677,305	$732,693,760	$772,532,108
Miscellaneous obligations	8,365,077	13,079,015	12,608,718
Income bonds	5,036,546	20,036,546	17,119,466
Equipment trust obligations	12,661,372	13,672,193	16,217,883
Total	$722,740,300	$779,481,514	$818,478,175

If the total capital liability of $1,588,937,526, as given above be divided by the 26,727 miles of operating line shown on a preceding page, the result would be $59,454 per mile of line. It would be quite misleading, however, to make such a calculation. Neither the divisor nor the dividend is correct. The mileage, for example, includes Government-owned and operated lines, to which no capital liability attaches. On the other hand, the capital figures embrace the liability of unfinished lines, such as the Grand Trunk Pacific, which do not appear in the mileage column. The deductions under this head amount to $134,321,020. Then there is considerable duplication. It has not been practicable to ascertain the exact amount thereof, created chiefly by the issue of stocks and bonds for the purchase or control of smaller roads by the larger, but it is known to be not less than $210,000,000. Joining these two sums, and subtracting the total from the $1,588,937,526 already indicated, the remainder is $1,244,616,506. For immediate statistical purposes that might be regarded as the proper capital liability of Canadian railways.

The elimination of Government-owned lines, and such other lines as should not figure in the mileage column, reduces the total to 24,485. Using these factors, it will be seen that the capital liability of railways in Canada amounts to $50,832 per mile. This is a relatively low figure

The mileage, capital cost, and cost per mile of Government-owned and operated railways are given in the following table:—

Government lines.	Miles of line.	Capital cost.	Cost per mile.
Intercolonial	1,463	$94,746,391	$64,761
Prince Edward Island	269	8,687,727	32,296
Temiskaming and Northern Ontario	302	17,665,500	58,495
New Brunswick Coal and Railway	58	1,936,600	33,398

Following is a table showing the facts with respect to the capital liability of Canadian railways since 1910:—

Year.	Stocks.	Funded debt.	Total.
1910	$687,557,387	$722,740,300	$1,410,297,687
1911	749,207,687	779,481,514	1,528,689,201
1912	770,459,351	818,478,175	1,588,937,526

The relationship of dividends and net earnings to share capital during the past three years is shown in the following tables:—

Year.	Dividends paid.	Share capital.	Per cent.
1910	$21,747,914	$687,557,387	3.16
1911	30,577,740	749,207,687	4.08
1912	31,164,791	770,459,351	4.04

Year.	Net earnings.	Share capital.	Per cent.
1910	$53,550,777	$687,557,387	7.78
1911	57,698,709	749,207,687	7.70
1912	68,677,213	770,459,351	8.91

Of the foregoing payment of dividends, $18,487,000 was paid in common stock, and $12,677,791.31 on preferred stock.

Aid to Railways.

During the year $5,892,818.34 was given in cash as aid to railways. This sum includes $4,994,416.34 paid to the Grand Trunk Pacific under the Implement Clause of the agreement between the Dominion Government and that company. That clause provides that Government shall make up the difference between the amount realized on certain bonds and their par value. This is not exactly a subsidy; but there can be no question as to the propriety of classifying such a payment as aid. The whole amount of aid in cash for the year was made up as follows:—

By the Dominion	$5,858,163.34
By the Province	26,155.00
By municipalities	8,500.00
Total	$5,892,818.34

A discrepancy appears as between the aid given by Provinces in the table next succeeding and the table on a later page. It has arisen through defective records between the years 1875 and 1890, which cannot now be corrected: so both statements are published.

Following is an analysis of the cash subsidies paid by the various Provinces since 1910:—

Year.	Ontario.	Quebec.	Nova Scotia.	New Brunswick.
1910	$9,198,616.04	$12,328,196.52	$6,384,299.75	$4,851,486.71
1911	9,204,616.04	12,333,196.52	6,384,299.75	4,907,486.71
1912	9,204,616.04	12,333,196.52	6,440,454.75	4,907,486.71

Year.	British Columbia.	Manitoba.	Totals.
1910	$702,209.00	$2,878,887.02	$36,424,305.04
1911	798,209.00	2,878,887.02	36,506,605.04
1912	804,209.00	2,878,887.02	36,532,850.04

Following is an analysis of the various forms in which cash aid has been given to railways by the Dominion, by the Provinces and by Municipalities:—

Dominion.

Cash subsidies	$ 80,558,911.30
Loans	25,576,533.33
Cost of lines handed over to C.P.R.	37,785,319.97
Paid to Quebec Government	5,160,053.83
Implement Clause, G.T.P. agreement	4,994,416.66
Total	$154,075,235.09

The Dominion Government is also constructing the Eastern Division of the National Transcontinental Railway, on which an expenditure of $116,533,768.53 had taken place up to March 31st, 1912.

Provinces.

Cash subsidies	$ 32,895,485.16
Loans	2,750,030.00
Subsriptions to shares	300,000.00
Total	$ 35,945,515.16

Municipalities.

Cash subsidies	$ 12,807,324.98
Loans	2,404,498.62
Subscriptions to shares	2,839,500.00
Total	$ 18,051,323.60

Land Grants.

Following have been the land grants to railway:—

	Acres
By the Dominion	31,864,074
By the Province of Quebec	13,625,949
By the Province of British Columbia	8,119,221
By the Province of New Brunswick	1,647,772
By the Province of Nova Scotia	160,000
By the Province of Ontario	635,039
Total	56,052,055

Summarizing the guarantees by the Dominion and Provinces, the result is as follows:—

	1911.	1912.
Dominion	$ 52,439,865	$ 91,983,553
Manitoba	20,899,660	20,899,660
Alberta	25,743,000	45,489,000
Saskatchewan	11,999,000	32,500,000
Ontario	7,860,000	7,860,000
Nova Scotia	5,022,000	5,022,000
British Columbia	23,196,832	38,946,832
New Brunswick	700,000	1,893,000
Quebec	476,000	476,000
Total	$148,336,357	$245,070,045

The above total of guarantees represents an increase for 1912 over 1911 of $96,733,688.

Public Service of Railway.

The public service of railways in 1912 was represented in the carrying of 41,124,181 passengers and 89,444,331 tons of freight.

In passengers carried there was an increase over 1911 of 4,026,463, and in freight hauled of 9,560,049 tons.

Passenger Traffic.

The number of passengers carried in 1912 was 41,124,181—an increase of 4,026,463, or 10.8 per cent. over 1911.

The number of passengers carried one mile was 2,910,-251,636, which was 304,282,712 more than in 1911.

The number of passengers carried one mile per mile of line was 108,888, as compared with 102,597 in 1911. This represented an increase of 6,291 in passenger density.

The number of passengers carried per mile of line was 1,539—an increase of 79 for the year.

The average revenue per passenger per mile was 1.943 cents, which was .001 below the figures for 1911.

The aggregate earnings from passenger service which included express, mails, baggage, etc. was $65,046,186.[illegible] This represented a gain over the preceding year of $[illegible],730,188.21.

The earnings directly from ticket sales to passengers were $56,543,063.60, or $5,976,769.62 more than in 1911.

The average number of passengers per train was 62, as compared with 60 in 1911.

The average passenger journey was 71 miles a gain of one mile over the preceding year.

The average receipts per passenger, using only the revenue from ticket sales as the chief factor, were $1.375 a betterment of .015 as compared with 1911.

The mileage of passenger trains was 40,440,[illegible]3, and of mixed trains 6,473,882 an increase of 3,454,482 miles in the former and of 106,414 in the latter. In preceding calculations these two mileages were combined and used as the total passenger train mileage.

The earnings from passenger train service per passenger train mile—which includes express, mails, baggage, etc.—was $1.387. This was an increase of .030 over 1911.

Freight Traffic.

The volume of freight traffic was 89,444,331 tons, which, as compared with the preceding year, showed an increase of of 9,560,049 tons, or 11.9 per cent. This was the largest increase in the history of Canadian railways.

The number of tons hauled one mile was 19,558,109,52[illegible]—a gain of 3,560,712,232 ton miles as against the figures for 1911.

The number of tons hauled one mile per mile of line was 731,776, which represented a betterment in the density of freight traffic, as compared with 1911, of 99,947.

The average revenue from freight per ton per mile was .757 cent, as compared with .777 in 1911.

Revenue from freight proper amounted to $148,030,898.60, a betterment of $23,287,883.29 over the preceding year.

The aggregate revenue from freight service for the year was $149,961,140.13, which represented an increase of $23,-390,606.61 over 1911.

The gross earnings from freight were equal to $5,610.85 per mile of line—an advance of $626.76 over 1911.

Per ton, gross earnings from freight amounted to $1,655, or .004 better than in 1911.

The average number of loaded cars per freight train was 18.19, or .16 better than for the preceding year.

The average number of empty freight cars per freight train in 1912 was 5.17. The number in 1911 was 5.04.

The average number of tons per loaded freight car was 17.87, showing a gain over 1911 of .96.

The average freight haul was 218 miles, as against 200 miles in 1911—a gain of 18 miles.

The mileage of revenue freight trains was 60,126,023, which included mixed train mileage. This total represented an increase, as compared with 1911, of 6,627,157.

The mileage of loaded freight cars was 1,102,719,543, as against 946,946,917 in 1911.

Following is an analysis of the commodities which are placed in classes that constituted the freight traffic since 1910:—

	1910. Tons.	1911. Tons.	1921. Tons.
Products of agriculture	12,891,351	13,809,536	17,300,945
Products of animals	2,765,006	3,190,702	3,159,280
Products of mines	26,152,022	28,652,236	31,467,709
Products of forest	13,068,940	13,238,347	14,152,721
Manufactures	10,014,279	13,573,987	16,241,081
Merchandise	2,518,190	2,438,089	2,711,963
Miscellaneous	7,073,078	4,981,385	4,410,542
Totals	74,482,866	79,884,282	89,444,331

Of the total freight tonnage of 89,444,331, 63,186,732 tons were returned as "originating on this road." The tonnage so returned in 1911 was 55,152,430.

Earnings and Operating Expenses.

The gross earnings for 1912 were $219,403,752.79 as compared with $188,733,493.81 in 1911. The increment was $30,670,258.98, or equal to 16.2 per cent.

Operating expenses for the year were $150,726,539.87—an increase of $19,691,754.92, or 15.0 per cent.

The ratio of operating expenses to gross earnings was 68.7 per cent.—a decrease of .7 as compared with 1911.

The following table gives the gross earnings and operating expenses, with the ratio borne by the latter to the former, since 1910:—

Year.	Earnings.	Operating expenses.	Percentage of operating expenses to earnings.
1910	173,956,217	120,405,440	69.2
1911	188,733,494	131,033,785	69.4
1912	219,403,753	150,726,540	68.7

Earnings.

The difference between gross earnings and operating expenses was $68,677,212.92, as compared with $57,698,708.86 in 1911. These are popularly regarded as net earnings; but correct accounting methods require that certain deductions, such as interest on funded debt, taxes, rents, etc., shall be made before the real net corporate income is declared Table No. 9, in the body of the subjoined report, deals with the revenues of railway companies in this way.

The balance actually carried forward to profit and loss for the year according to the method followed in the preparation of Table No. 9, was $20,146,869.29, as against $14,150,464.67 in 1911.

The revenue during the year from outside operations amounted to $21,221,774.67, and operating expenses attached thereto, $15,333,617.50. The net revenue from this source in 1912 was $5,888,157.17, or $593,728.35 more than in 1911.

DECREASED PRODUCTION OF IRON ORE

An interesting white paper was recently issued by the British Government, containing statistics of the production and consumption of iron ore and pig-iron and the production of steel in the United Kingdom and the principal foreign countries in recent years, with additionally the imports and exports of certain classes of iron and steel manufactures. It states that the combined output of iron ore in the ten principal countries dealt with exceeded in 1910 139 million tons, and if the output of the minor countries be added it is probable that the world's total production during that year was about 145 million tons. Complete statistics are not yet available for 1911, but the provincial figures show that the world's total output is unlikely to reach more than 120,000,000 tons, the United Kingdom's production figures, however, showing a slight increase.

The total quantity of pig iron produced in the world during 1911 is estimated at about 63,000,000 tons, the principal producing countries being the United States, Germany, and the United Kingdom, which between them account for about seven-ninths of the world's output. Particulars for the first half of 1912 show that the output of pig iron for the five principal producing countries during that period was about 29,400,000 tons, which compares with 27,600,000 tons during the second half-year of 1911. For the second half of 1912 the United States produced about 15,600,000 tons of pig iron, Germany 9,277,000 tons and Belgium about 1,203,000 tons.

EARTH AND GRAVEL ROADS.*

By Robert C. Terrell.†

I feel a delicacy in discussing this very important problem of earth and gravel roads. As this class of roads comprises more than ninety per cent. of the total mileage of roads in the United States, and since there are more than 2,150,000 miles of road, you can readily see how important it is to have the earth and gravel road maintained in good condition for travel.

Earth and gravel roads—as is the case with most of our roads, it matters not of what material they may be constructed—have two natural enemies—water and politics—and the latter point is not to be overlooked. Water, however, is the subject that attracts the greatest attention in the road maintenance; and, since water and politics do not mix very readily, we will discuss the former.

Thorough drainage is the most important problem that confronts the engineer or road builder. Earth roads must be well drained and properly crowned, in order to be serviceable at all times. The maintenance of a road thus constructed is comparatively easy and not very expensive if the work is done at the proper time, but good drainage is very costly, if not altogether impossible, unless the road is properly located.

A road, in order to be properly drained, must have the proper longitudinal grade; a minimum grade of 0.5 per cent., with a maximum grade of 5.0 per cent., which may be increased, depending upon the amount of traffic and the obstacles met in locating. The minimum grade is necessary in order to give the side ditches the proper amount of fall to carry the water quickly and rapidly along and away from the road. The side ditches should be built of a sufficient width to successfully carry all of the water coming into them, having side slopes of 1½ to 1, or 1½ horizontal to 1 foot vertical, which will prevent the earth from the side caving in either from excessive wet weather, or from freezing and thawing. Side ditches should never be made deep and narrow. If extra drainage is necessary, they should be underdrained by use of tile or by excavating a deep ditch, filling with large stones, or making stone boxes and covering these stones with smaller ones and finally covering with sod, the sod side down, or hay, straw, or shavings from a planing mill, to prevent dirt from washing into the inside drain, leaving a shallow ditch on top. Deep, narrow ditches are dangerous to travel and otherwise objectionable, in that they catch trash and cause clogging, thus forming pools along the side of the road, permitting the water to seep into the foundation of the road and soften it. Where roads are located along sidehills a ditch on the upper side sufficient to take all the water coming down the hill is necessary and if it cannot be constructed immediately along the side of the road, there should be an additional ditch constructed above the road and parallel to it, intercepting the water from the hill and carrying it along the same general direction with a sufficiently small grade to prevent washing or gullying of the ditch. Where the grade exceeds 5 per cent., the ditch should be paved with stone and the water should be carried under the road from the upper side at short intervals and disposed of without permitting it to collect in sufficient quantities to damage the side of the road or break across it.

---

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati,

† Commissioner of Public Roads of Kentucky.

NOTE.—Space allowed only a short abstract of this paper in an earlier number. On account of the number and importance of earth and gravel roads in the Dominion, it has been deemed advisable to publish the paper in full.

Under, or subsoil, drainage is frequently necessary where roads are located on low or marshy soil and should be secured by a line of farm drain tile on either side, or by placing the tile immediately under the road. This farm or porous tile placed 34 to 36 ins. deep, and with a grade of ½ to 1 per cent. longitudinally, will keep the foundation of the road free from water, thus leaving the road hard and compact at all times.

Earth and gravel roads should have more care given to their location than roads surfaced with more permanent material, and probably receive less attention. In locating roads attention should be paid to the character of the surface of the soil over which the road is to pass. Clays form very poor surfaces and even among the clay soils there is as much variation of the fitness of the material for forming road surfaces as there is in variation of soils for farming purposes. These poor soils require more careful study and can withstand the effect due to bad location less than any other materials used for road building purposes. However, in many instances the roads have already been located with little or no prospects of change and to relocate a road means, in many instances, the purchase of expensive rights of way, and the changing of routes often causes trouble, because of the improved property along the old right of way.

For the clay soils, roads should be located where the sun has free access to the surface—preferably having a southern or western exposure and having a small amount of shade from trees and shrubbery. Where sandy or gravelly soil is available, it makes a better location for a road than the softer and less durable soils. As a sandy or gravelly soil sheds water very readily, being more porous, permitting the water to seep down and out; it requires less attention for drainage and shade. Sand makes a better surface for roads when damp.

If the road has been properly located and properly drained, probably the point of most importance is the crown or cross grade. There are several forms of cross section, but the parabola form, in my judgment, is the best, having a centre elevation equal to 1/24 of the width of the road. This form permits the more general use of the entire width of the road, as wagons getting across the middle of the road do not slide immediately into the side ditch. However, the parabola form is more costly, as it requires more care in construction. The uniform slope may be used to an advantage on account of the cheapness of constructing the uniform grade by means of the scraping grader, and probably is just as effective. If the uniform slope is used, ½ to 1 in. to the foot will be sufficient, and if traffic is not permitted to concentrate at the centre of the road and form ruts, the water will be carried quickly and effectively to the side ditches.

Mud holes have no place in roads well crowned, properly located, and properly ditched, and ordinarily they will not occur. However, the surface will become soft by constant pressure of water from underneath and can only be maintained in good condition for travel by putting in the subsoil or porous tile drains. Other frequent causes of mud holes are the unevenness in the texture of the soil and the combining of vegetable matter with the soil while working the roads; this vegetable matter holds water, thus damaging the surface. In no case should stone be piled into a mud hole, as it only forms a rough and unsatisfactory surface and permits the formation of mud holes at either end from the impact of loaded vehicles dropping from the harder surface of stones to the soil surface beyond. The road, however, can be successfully repaired by the removing of the softer soils, or soils containing vegetable matters and replacing with clay, or soil of the same consistency as the remaining portions of the road, and by removing the [illegible] so that the sun may have free access to that portion of the road.

An earth road, like all farm land, should have its principal working in the spring of the year when the soils will work most readily and will have time to become consolidated before the fall rains begin. A scraping grader drawn by a traction engine will do excellent work in giving a road sufficient crown, and the side ditches may also be opened by the use of the scraping grader. The earth removed from side ditches should not be thrown into the centre of the road but should be thrown out to the opposite side or left in such condition that it could be easily removed from the surface of the road entirely and should never be placed where it could be carried back into the ditches by reason of water falling on the surface.

In crowning a road in early spring with a road machine care should be taken that no second or shoulder ditch be left between the centre and the edge of the ditch supposed to carry the drainage, as such a ditch only tends to hold water falling on the surface and soften the subgrade rather than offering an opportunity for the water to be carried away. After the road is properly crowned in the early spring, it will need only slight care during the summer and fall months and in most instances this work can be effectively accomplished by the use of the split log drag. A light drag is preferable, which can be easily drawn by two horses.

It is not necessary for me to go into detail with reference to the construction of one of these excellent pieces of road machinery, as everyone who is interested in road building knows perfectly well the advantages to be gained by the use of a drag.

The amount of road improved by gravel more than equals the amount of road constructed by the use of other materials—probably next to earth roads is the most important—because of the quantity of road surfaced with this material and its low cost and easy method of construction. The same care should be given to the location and drainage as is given to the earth road. In the construction of the gravel road, beginning with the subgrade, it is probably best to open the trench to receive the gravel, giving it the same crown or cross section as the finished roadbed should have, which should be a parabola, with the centre height equal to 1/40 of the width of the road. The subgrade should be properly rolled, beginning at the edges and rolling toward the centre, as you would the finished road, and where soft places or uneven surfaces appear, they should be filled and shaped and the rolling continued until the surface is entirely smooth. The gravel should not be dumped in piles as it forms a wavelike appearance after the road becomes thoroughly consolidated, but should be dumped on boards or shoveled out of the wagon and to the roadbed, spreading evenly and in layers of from 4 to 6 ins.

Gravels containing clay or sand, or even loam, not exceeding 20 per cent. of the entire quantity, make excellent road material and will bind or compact very readily. After the gravel has been properly placed on the subgrade it should be thoroughly sprinkled and rolled, the rolling beginning at the edge of the ditch and rolling the shoulder in the same manner as the gravel, so as to have an even surface for the water to shed from the centre to the side ditch.

In many instances, however, it is not possible to secure a roller for consolidating the gravel. In that case the gravel can be properly shaped and thrown open to travel, care being taken to fill wheel ruts by moving the loose stones in with a rake until the road has been consolidated to an even surface and having proper cross section. If this care is not given to the gravel when first placed and unrolled, ruts will form on either side by the constant rolling of vehicles in the

same tracks and will prevent the water from reaching the side ditches and form channels in which the water will collect and cause much damage.

In western Kentucky our gravel roads cost approximately $1,000 per mile, while in eastern Kentucky, where the country is more hilly and less attention has been paid in the past to the proper maintenance of earth roads, which are being converted into gravel roads, the cost is slightly higher.

In my opinion the maintenance of earth and gravel roads will never be effectively accomplished until we receive government aid for all post-roads and until every road becomes a post-road. I do not mean, however, by "government aid" that the government shall bear the entire or major portion of the expense of constructing or maintaining any road or roads in the Union, but that the government will merely assist in the construction and maintenance of roads to such an extent as will enable the government to direct the local authorities how the work must be done before the federal aid is available, and then that these roads be put under direct government inspection by making each and every rural mail carrier the inspector of his route, reporting deficiencies in the road as they occur to the local authorities and to make reports to the federal government once each month as to the condition of the road.

THE CONSTRUCTION OF REINFORCED CONCRETE SYPHONS OF THE CHENAB IRRIGATION CANAL.

The Chenab Canal, Punjab, India, is the most advanced of what is called the triple canal project now under construction, and with which Mr. Scott, who gave this description at the Institute of Civil Engineers, Ireland, is connected. It obtains its supply from a weir that is thrown across the river just below the point of the offtake of the canal, about 40 miles from the point where the river emerges from the Himalayan Mountains. It has a bed width of 240 feet and a full supply depth of 12 feet, with a discharge of 12,000 cubic feet per second.

The first 26 miles of the main line of the canal passes through a fertile district which has a plentiful rainfall, therefore, no irrigation will take place within its reach, but owing to its proximity to the hills the alignments had to be carried across several drainage lines which, during the rainy season, carry high supplies, therefore, in order to pass the storm water safely under the canal it was necessary to construct several syphons in the upper portions of the head reach.

Of the twelve syphons used eleven were of reinforced concrete, which is an experiment in India, and especially in the Punjab, owing to the extremes of temperature that the concrete will be exposed to, and will be an experience as to how it stands the test. The syphons are cheaper to build and will stand the pressure better than would massive deep foundations of brick masonry, these being more or less submerged, will offer a great protection for the concrete

The dimensions of the largest of these syphons is as follows:—

Estimated discharge	2,550 cusecs
Number of barrels	8
Length of the barrels	342 feet
Diameter of the barrels	6.5 "
Thickness under canal bed	6½ inches
Thickness under canal banks	7½ "
Head of internal hydraulic pressure	15.00 feet
Depth of foundation below spring level	12.00 "
Design of foundation—slab of concrete	2 ft. thick

The Portland cement concrete used in the barrels of the syphons was made up in the following proportions:—

Portland cement	60 lbs.
Sand	100 lbs.
Ballast	160 lbs.
Water	22 lbs.

The Portland cement was obtained from England by indent of the secretary of state of India, and complied with the specifications of the India office. The aggregate consisted of broken quartzite boulders obtained from the bed of the Chenab River and broken in a Baxter stone-breaker to a size that each piece should pass through a ring of half-inch diameter. The sand consisted of the same material crushed to a much finer degree. A block of this concrete, tested after one month, gave a resistence to crushing of 1,380 lbs. per square inch.

The exact proportions of the concrete used in the foundation are as follows:—

Brick ballast	120 cubic feet
Kankar lime	30 "
White lime	10 "
Crushed brick or Surkhi	10 "

It was hand-mixed on brick platforms, carried in baskets to the work, and rammed in 6-inch layers which formed a very hard concrete and was also hydraulic. This syphon will cost in the neighborhood of $50,000 (£10,333).

Nearly every person who has not travelled to India are generally under the erroneous impression that work is done in a leasurely fashion. With only two European engineers to supervise the work of the reinforcement, centrings and laying of the concrete, what would be a simple operation in this country assumed large proportions in India, as the work was new to the men and the staff and coolies had to be trained up to the work, which was done under awnings to protect the concrete from the heat of the sun. But, despite all this, and with the temperature nearly always in the neighborhood of 90 degrees Fahr., the work was completed well within the anticipated time.

UNION FREIGHT STATIONS.

Union freight stations will in time be established in all large commercial centres, says L. C. Fritch, chief engineer of the Chicago Great Western Railroad.

A plan for consolidating the passenger and freight terminals in Chicago has recently been proposed. The plan is commendable, although to bring it about certain railroads would have to give up valuable vantage points in the interests of economy and improved service for all. The union terminal should, Mr. Fritch believes, be operated by a terminal company, equal service being rendered to all lines. This undertaking, tremendous at first thought, is nevertheless feasible and is simplified by the fact that Chicago is the terminus of all the lines entering the city, so that only small portions of the ends of main lines would be out of the hands of the individual railroad companies.

A step toward such a plan would be the aquisition of all belt lines now existing in the Chicago district. They should be owned jointly by all the railroads entering the city, and should afford all such railroads equal access to all facilities and industries located on them. There are four or five principal belt lines in the district, and in some cases lines badly congested are paralleled by lines little used. Common ownership would make it possible to balance the traffic on the different lines, would eliminate the necessity for increased facilities on the lines now congested, and would enable each road entering the city to get its belt line service at actual cost.

The Canadian Engineer

ESTABLISHED 1893

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3 00 (12s.)	**$1.75** (7s.)	**$1·00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T R Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, MARCH 13, 1913. No. 11.

CONTENTS OF THIS ISSUE.

A COURSE IN HIGHWAY ENGINEERING.

In an address given before the recent Ontario Good Roads Association meeting, Mr A. T. Laing, the secretary of the Faculty of Engineering, University of Toronto, outlined the plans of that institution to meet the present-day requirements of trained highway engineers. Dean Galbraith, as the head of the Faculty of Engineering, is again to be congratulated on his continued putting into force of those lectures and courses which improve the value and opportunities of his graduating students. In their final year they are to be given besides lectures on roads, pavements, maintenance, etc., a laboratory course in the examination of road metals and bituminous materials.

Modern highway engineering cannot be properly carried on without the employment of technically trained men. With the present-day movement towards good roads throughout the country, every school of engineering should make provision for special lectures in that branch of work. Some of the state road associations across the border make special provision for keeping young men working with them on practical work in the summer and attending schools and lectures on highway engineering in the winter. No doubt some such arrangement will be arrived at in this country as the demand for such men increases.

Students spending their summers on practical road work of different types, obtaining in the winter supplementary technical information on the subject, ought to be in a position to be of considerable service when they graduate. The schools of engineering and road associations in all parts of Canada should work together to this end. The full text of Mr. Laing's address on this subject is given on another page.

ELECTRIFICATION OF RAILWAYS.

The Chicago, Milwaukee and Puget Sound Railway is preparing to operate electrically through part of Montana and Idaho, and has signed a contract for the electric energy needed. In so far as many Canadians expect to see some of our steam railways finally forced through economy of operation to electrify in many localities, it is of interest to note the terms of the contract made for power by the railway in question.

The railway is not to be liable for interruption to its consumption of energy due to causes beyond their control, such as strikes, fires, etc. Neither is the power company liable for interruption to supply due to the same causes. Two years' notice to commence delivery of energy must be given the power company, and the railway must electrify its line before 1918. The railway agrees to buy energy at the rate of 10,000 kilowatt for a full period of ninety-nine years. It has options to buy more power from the power company up to a maximum of 25,000 kilowatt. The permissible call for additional energy from the power company is scaled both as regards amounts and necessary time notice beforehand. These additional amounts once called for will be delivered for the entire remaining time of the contract. The power company in making delivery of energy, is to provide

energy at either 50,000 volts or 100,000 volts, three-phase, sixty cycle, and is not to be called on to deliver at more than five stations; the railway company to be responsible for distribution. The railway is also forbidden to sell to others any of the energy purchased.

In an endeavor to avoid any misunderstandings, provision has been made for a board of arbitrators to settle disputes of any nature between the companies interested. This board is to consist of three parties, one representative from each company and the third party selected by the first two.

Such a board is to be commended, and ought to facilitate the efficient operation of such big contracts where it is almost impossible to cover all the details of construction and operation beforehand. The more general adoption of such a board of arbitrators in connection with contracts of this character should rather be encouraged.

The power company pays the federal government a tax of five mills per 1,000 kilowatt hours for energy crossing domains. The rate paid the power company by the railway for energy is 5.36 mills per kilowatt hour. This is subject to a minimum bill of 60 per cent. of all the energy contracted for by the railway. It will be seen that this provision of a minimum charge makes it incumbent upon the railway to operate so efficiently that 60 per cent. of the energy supplied is under use. Otherwise, they will not benefit by the low rate.

UTILIZATION OF TIDAL ACTION.

Readers will remember a few years ago that the newspapers had considerable in their columns regarding a scheme for utilizing tidal action for developing electricity. The Bay of Fundy has a tidal movement of 50 or 70 feet, and was spoken of as the locality where electric development by this means would be immediately started. A site was spoken of, but it is our impression that no construction work was ever started. Apropos of the above comes word of plans for development in Europe of 5,000 horse-power by this means at Husum on the North Sea.

A reservoir of 4,000 acres is to be constructed by means of two embankments running from an island to the mainland. The reservoir is to be further subdivided into an upper and lower tank by another embankment. The assumptions for operation are as follows: When the water in the sea is higher than in the lower reservoir or tank, it will flow in through turbines, the flow starting sometime after high tide and stopping after the beginning of low tide. If the water in the sea be lower than in this tank, then through sluices it is to flow into the sea. In the upper reservoir, when the sea is higher than the tank, it will be filled through sluices, and when lower the water will flow off through turbines. A uniform tidal amplitude of three meters is counted upon and a difference of level of one and a half meters between the sea and the tank actually in operation. The cost of producing electricity by this means is estimated at 20 to 25 mills per kilowatt hour. No necessary expense for accumulators is expected, and the cost of construction is placed at about $1,000,000.

The scheme has been very severely criticized in a German technical paper by Mr. L. Benjamin. While it is not our purpose to pay any attention to his criticisms of the estimated expense of the project, we think criticism of the practical operation of such a plant worth considering and interesting. If it is a feasible and practical plant at all, with a tidal amplitude of only three meters, it ought to mean wonderful possibilities for electrical development in Canada in the Bay of Fundy. In the criticism of the practical operation of such a scheme by the German paper before mentioned, the objections are principally on the following points:—

After making allowance for back pressure and the head necessary to bring the water from the remoter parts of the reservoir to the turbines, the maximum head available would only amount to one meter, and falls to zero in a working period. In the most favorable case the dynamos would only work for a period of about four hours, followed by a standstill of two hours. The energy would have to be stored for distribution to consumers, and expensive accumulators would become necessary. Turbines suitable for one meter head are not suitable for less than one-half meter, and consequently more turbines become necessary.

Summing up the criticism, it amounts to the fact that the final cost of electric energy delivered to the consumer by this plan would be prohibitive and far beyond a properly designed steam plant.

The affair, as far as a proposed plant at Husum is concerned, savors of wild-catting and stock promotion. The market for the distribution of energy is at considerable distance from the proposed site, and in every way it would appear to be a very expensive and impractical plant.

In Canada it is probable that the inland water powers are sufficient, and can be more economically developed for the use of the people of New Brunswick and Nova Scotia than any possible present harnessing of the high tides on the shores of the Bay of Fundy. It is interesting, however, in looking forward, to see a tremendous field for electric development as above in Eastern Canada. The Bay of Fundy is the locality of the greatest tidal amplitude of movement in the world. It will be strange, indeed, if the first works to put the scheme to practical test are not located there. Any urgent demand or necessity for power in that region will probably lead to an attempt to develop electric energy by the above means.

EDITORIAL COMMENT.

Oil production in Canada, as shown in the statistics published on another page, is steadily decreasing. This is probably the only product of Canada's wealth or natural resources, the production of which has steadily declined in the last five years. We are of the opinion that this movement is only temporary. There are yet tremendous and promising tracts of land to be properly prospected for oil. It is to be hoped the engineer and geologist will soon locate it in abundance. It would be unfortunate, indeed, if, as a country, we were lacking in such a product, so largely used in the arts and manufactures.

STORM WATER DISCHARGE.

R. O. Wynne-Roberts * and T. Brockmann.†

(Continued from page 375).

Before proceeding to explain the method of constructing flow areas and curves, it will be necessary to submit the following formulæ:—

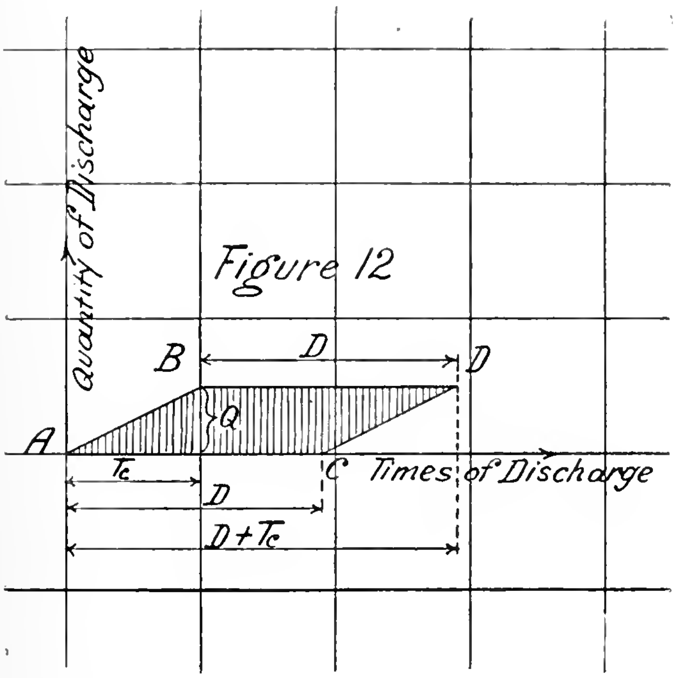
Let Q = Volume of storm water discharged in cubic feet per second, when the whole of the drainage area is contributory.

Qt = Volume of storm water discharging at any time during or after a storm, in cubic feet per second.

P = Coefficient of impermeability, taken from diagram or table.

R = Quantity of rain, reduced to cubic feet per second per acre.

I = Coefficient of rainfall intensity, see table or diagram.



A = Drainage area, in acres.

Tc = Time required for storm water to concentrate at the lower end on the sewer of "L" length, in minutes.

L = Length of sewer, in feet.

V = Mean velocity of flow in sewer, in feet per second.

D = Duration of storm, in minutes.

T = Any time, in minutes.

Then (1) $Tc = \frac{L}{V}$

and (2) $Q = P \times I \times R \times A$.

In the preliminary design of a sewerage system the length of any particular section is known, and the velocity of flow may be assumed at, say, three feet per second, when running half-full or full, so that the time Tc required for the storm water under such condition to flow from point to point can be easily ascertained by formula (1).

The duration of a storm is "D," and the ordinates representing the volume of storm water "Qt" for any time "T" will be as follows:—

If "T" is greater than zero and less than "Tc," then

$$Qt = \frac{T}{Tc} \times Q.$$

If "T" is greater than Tc and less than D, then Qt = Q.

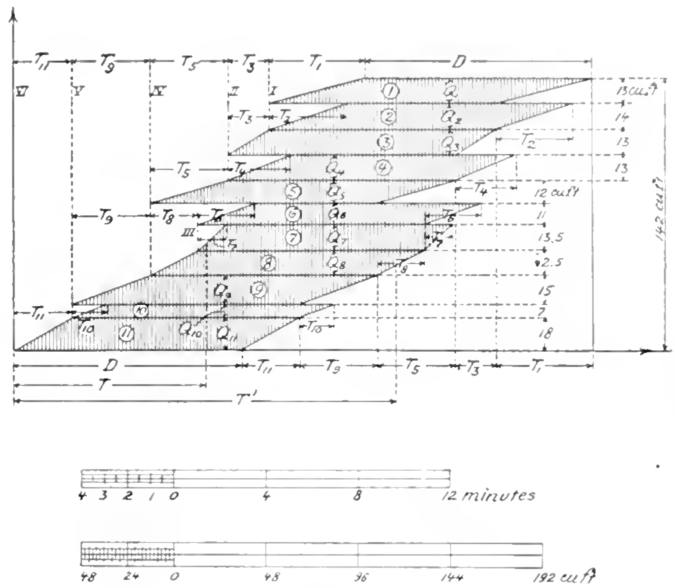


Fig. 14.

If T is greater than D and less than D + Tc, then

$$Qt = \frac{(Tc\ D) - T}{Tc} \times Q.$$

If (D + Tc) is less than T, then Q = O.

(See Figure 12.)

The left-hand slope A-B (of Figure 12) of the flow-area is parallel to the right-hand slope C-D.

The volume of storm water run-off is represented by the flow area, having the shape of the rhomboid A-B-D-C, and the period of concentration, as well as the quantity discharged at any time at the lower end of any sewer having "L" length, and during any storm of "D" duration is clearly indicated in the diagram (Figure 12). It may be explained that in this case the direction of the flow is from the right

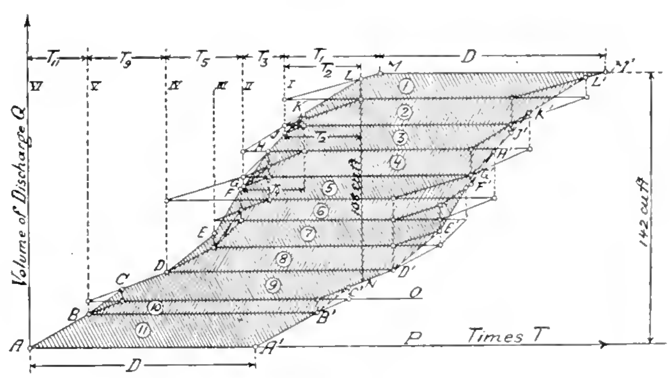


Fig. 15.

to the left, and the outlet is situated at the toe-point A.

Recapitulation.—It is to be hoped that what has already been stated regarding the problem of calculating the quantity of storm water, to be dealt with in any district, has been expressed in explicit terms, and that it will be recognized that, having regard to the variable factors which have to be considered, the best way of arriving at a satisfactory solution will be by drawing flow-areas.

* M. Inst. C.E., F. R. San. Inst., Consulting Engineer, Regina.

† Dipl. Ing. (Berlin), Civil Engineer, Regina.

The engineer will, therefore, have first to

1. Assume the intensity of the rainfall.
2. To ascertain if retardation takes place.
3. If retardation does not take place, then use formula.
4. If retardation does take place, then to draw flow-areas.

Example.—A complete example will now be worked out to illustrate the method which the writers submit is the more rational one to follow.

Plan shown in Figure 13 is presented as a typical layout of a sewerage system for storm water. There are six sections to which eleven areas are to be drained.

Assumptions—

Duration of storm = 10 minutes, or 600 seconds.

Rainfall = 2 cubic feet per second per acre.

The volumes of discharge for the other ten areas can be arrived at by analogous calculations and the following results will be obtained:—

Section	1	13 cubic feet per second.
"	2	14 " " "
"	3	13 " " "
"	4	13 " " "
"	5	12 " " "
"	6	11 " " "
"	7	13.5 " " "
"	8	12.5 " " "
"	9	15 " " "
"	10	7 " " "
"	11	18 " " "
Total		142 cubic feet per second.

So that the total discharge at manhole VI. amounts to 142 cubic feet per second.

Figure 14 shows the floor area for each section and drainage area illustrated in Figure 13.

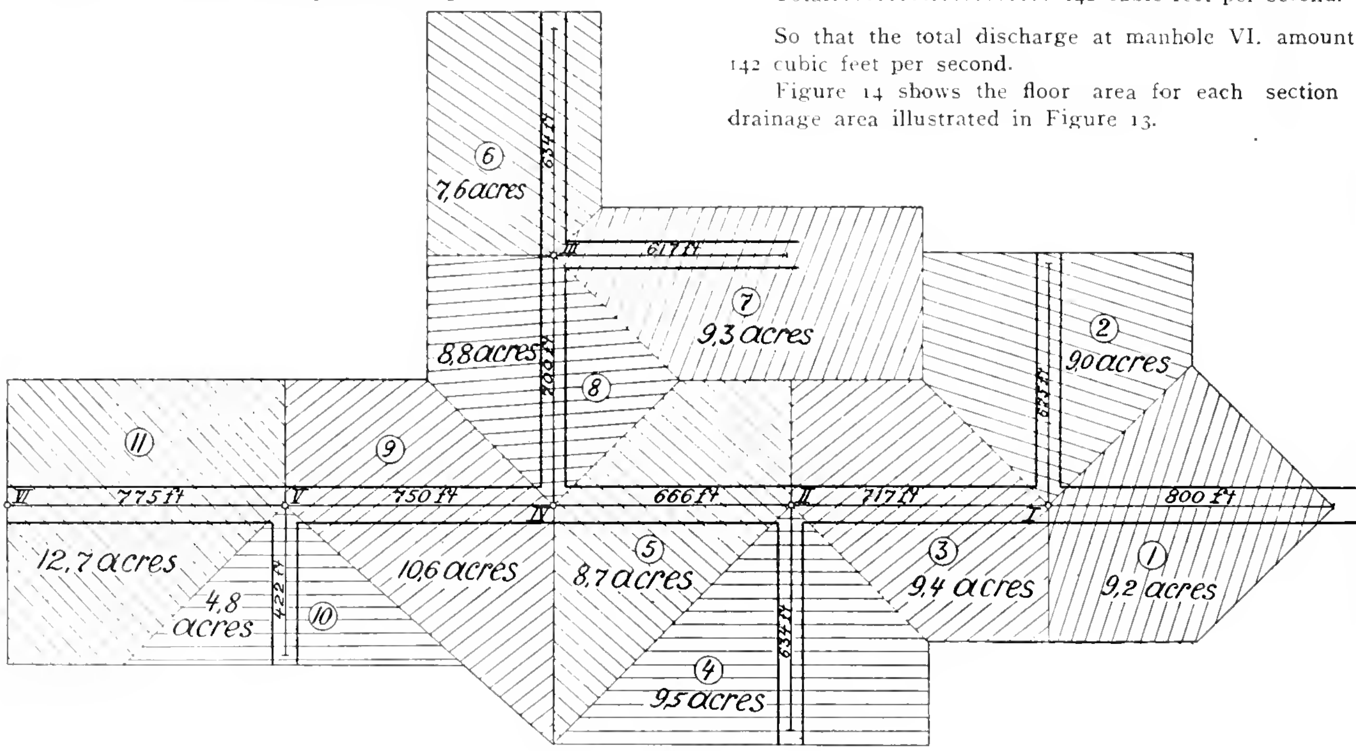


Fig. 13.

Scales of the flow-areas are—

Time one inch = four minutes.

Volume of discharge, $\frac{1}{48}$ inch = 1 cubic foot.

Commencing with Section 1—

L = 800 feet.

V = 3.2 feet per second.

Time of concentration $= \frac{L}{V} = \frac{800}{3.2} = 250$ seconds, or 4 mins. 10 secs.

Coefficient of impermeability for, say, 70 persons per acre, as per diagram = 0.77.

Coefficient of intensity for a section 800 feet long, as per table, equals $1 - 0.0028\sqrt{800} = 0.92$.

The drainage area for Section 1 is 9.2 acres.

Accordingly the volume of discharge will be:—

Q = Area × rainfall × coeff. of impermeability × coeff. of intensity.

$Q = A \times R \times P \times I = 9.2 \times 2 \times 0.77 \times 0.92.$

Q = 13 cubic feet per second.

Having ascertained the time of concentration and the volume of discharge as above, the flow-area is plotted in the top right-hand portion of the diagram (Figure 14).

Those who wish to draw similar charts may be guided by the following simple rules:—

1. Start by drawing the flow-area of the section of sewer lying near the remote limits of a district, that is, the farthest from the point of outlet, and then proceed, section by section, downwards, in the direction of the flow.

2. Flow-areas of sewers which meet at a manhole have the same abscissæ; i.e., the toe-points of their ascending slopes are located perpendicularly above each other.

3. The flow-area of a sewer section located between two manholes is to be drawn beneath those of the upper sections, the toe-point being moved leftwards a distance corresponding to the time of concentration for that particular sewer.

4. Secondary collecting sewers joining the main sewers will have to be dealt with in a similar manner.

The chart illustrated in Figure 14 has been constructed in accordance with the foregoing rules.

The volume of discharge passing through manhole VI. at the time "T" is represented by an ordinate erected at "T," and cutting the flow-areas 11-5. The parts of the erected ordinate which signify discharge are those which lie within the shaded areas. The flow-areas 4-1 are not passed through by the ordinate, which shows that they are not yet contributing, whereas, at the time "T¹" the sections repre-

sented by the flow-areas 8-1 are discharging into manhole VI., while the water from sections represented by flow-areas 11-9 has already run off.

Figure 15 has been prepared by depressing the projecting points on the left and elevating those on the right to the area next to them, and so a flow-curve is obtained which is characteristic for the volume of storm water discharge at any time from the whole drainage area under discussion.

It will suffice to construct only the ascending curves A-B-C, etc., because the descending curves M'-L'-K', etc., are parallel to them.

The largest ordinate of the total flow-area will give the maximum rate of flow on which the calculations of the sewer dimensions are to be based.

In the present example the ordinate L-N shows this maximum rate of flow to amount to 106 cubic feet per second, and this is the volume of storm water that must be provided for in Sections 9, 10 and 11.

The difference between M-P and L-N indicates how much the storm water discharge is modified by retardation. In this case the difference equals 142-106, or 36 cubic feet per second. In a like manner the difference between M-O and L-N represents the modification of the aggregate flow due to retardation in Sections 1 to 9 inclusive.

In conclusion, the writers have to urge upon city engineers and others the desirability of installing automatic recording rain gauges so as to obtain reliable information concerning the quantity of rain falling in short periods and in different districts, for without this data it is possible that the assumptions which will be made when designing storm water sewers may be erroneous and lead to inadequate or excessive provision for storm water. In each city the rainfall should be automatically recorded for those having a duration of 2 to 120 minutes, and such data plotted as shown in Figure 1, illustrating the intensity of rainfall. The rain gauges required for this purpose are to be had at a moderate price, whilst the information thus secured will be of great value.

NOTE:—The issue of The Canadian Engineer, Feb. 20th 1913, page 344, containing a preceding article by R. O. Wynne-Roberts and T. Brockmann on Storm Water Discharge, did not, unfortunately in printing, bring out many of the symbols r belonging to q. The part of the page needing correction is here reprinted together with more distinct $\sqrt{}$ signs and the omission of a dash over an x.

The corrected page should read:—

Line 22 — $\frac{q}{2}$ correct to "$\frac{q_r}{2}$".

Top of right hand column same page should read:

Let "A" be the zero point, then the parameter "p" is found from $10{,}000 \times p = \left(\frac{q_r}{2}\right)^2$ or "p" equals $\frac{q_r^2}{40{,}000}$; the equation of the parabola will be "y^2" $= \frac{q_r^2 \times x}{40{,}000}$.

The circumference described by the centre of gravity in revolving is $2 \times 0.6\, x \times x$, therefore the content of the solid of revolution corresponding to the shaded area (cylinder minus parabola) is $x^2 \pi\, q_r - \frac{2}{3}\, x\, y\, 1.2\, x\, \pi = x^2 \pi\, (q_r - 0{,}8\, y)$ and "I" $= \frac{x^2 \pi\, (q_r - 0{,}8\, y)}{x^2 \pi\, q_r} = 1 - 0{,}8 \frac{y}{q_r}$.

As $\frac{y}{q_r} = \sqrt{\frac{x}{40{,}000}}$, "I" $= 1 - \frac{0{,}8\sqrt{x}}{\sqrt{40{,}000}}$.

FAULTY CEMENT WORK.*

So simple does it seem to mix cement, sand, stone, and water, and embed therein steel rods, that the ordinary mind untrained in the refinements of technical calculation is apt to overlook the fact that a complicated theory underlies the construction. There are, consequently, builders who, while they would not dare to undertake a steel structure, yet consider themselves sufficiently "practical" to take a hand at reinforced concrete. Incompetence is thus too often set on high, and no more vengeful Juggernaut was ever enthroned to exact tribute of suffering and death.

To plan and to superintend reinforced concrete construction—we cannot repeat it too often—calls for more than the experience and common-sense of the so-called "practical" man; it is eminently work for the trained engineer.

No more emphatic demonstration of this was ever given than the example of failure presented in the remains of a motion picture theatre on Eastern Avenue, Cincinnati, Ohio, which was to have opened on New Year's day with a grand free-for-all show for as many women and children of the neighborhood as could crowd it. For weeks, every child in the neighborhood had been watching the completion of the new picture theatre; and many of them were all joy, for their mothers had promised to take them to that free show on New Year's day. By an act of the merciful hand of Providence, however, none of them attended. for, on December 10, the nearly completed theatre, without preliminary warning long enough to give the unsuspecting workmen a chance to escape, collapsed to the ground, carrying with it the ten workers who happened to be in the structure, instead of that happy throng of women and children. Had the structure stood until that opening day, it is conceded by all that it would have been the death trap for two hundred or more mothers and their children. As it is now, the story is three dead, six seriously injured, and one bruised.

The building was a reinforced concrete substructure of columns, beams, and slabs, with brick side and end walls forming the theatre proper. The concrete work was originally designed by an engineer employed by the architect; but it appears that the owner, on account of the high bids received, engaged a "practical" builder, who prepared his own plans, modifying the work of both the architect and the engineer, and agreeing to do the work for much less than the amount of the lowest bid. Neither architect nor engineer had anything to do with the supervision of the erection. Even the plans on which the building permit was issued were not followed out exactly, one column being omitted, thus increasing span between columns; and though the building commissioner required that the details of the girder to support the floor across this span be submitted, the builder failed to submit them.

The collapse occurred while the forms were being removed. The concrete had been in place only 18 days, the weather being generally cold and for a considerable part of the time below freezing. The folly of the whole thing, however, is strikingly shown in the way the steel was placed, no intelligent care whatsoever having been exercised. The rods in the girders were simply bunched together along the bottom, without being spaced so as to enable the steel to have any effective grip.

---

*Cement World.

Mr. J. G. Sullivan, chief engineer of Western lines of the Canadian Pacific Railroad, has stated that tenders are being called, to close April 15, for a great tunnel 28,000 feet long to cut through the Roger's Pass Hill.

REPORT OF THE TWENTY-SEVENTH ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

(Continued from last week).

Thursday, January 30th, 1913

Morning Session

THE PRESIDENT said they would continue the discussion re British Columbia Branches.

MR. ROBINSON said it appeared to him that this question was too large for a snap judgment. The matter needed thorough consideration over an extended time, so that whatever action they might see fit to take in this matter should be well weighed and their judgment mature.

He moved that the Council be instructed to take this matter under advisement and thoroughly thresh it out, with a view to proposing any amendment to the by-laws which may be necessary to accomplishing this which we are asking for.

He hoped that the matter would not take the form of action which would in any way weaken either the interests of the parent society or of the branches. They hoped that whatever action was taken would tend to increase the strength of both, thereby making a stronger and more vigorous society in every respect. In the discussion after the meeting yesterday afternoon informally, it was brought to his attention that some of the members considered it unnecessary to seek incorporation from the Provincial Government of British Columbia, and that the only thing necessary in the circumstances would be to register this society, which had a charter from the Federal Government, as an extra provincial organization doing business in British Columbia. His opinion at the present time was that that would accomplish the objects which they had asked for fully as well as to secure an independent charter. If the council saw fit to take such action, he would like to have this meeting give the council such authority as might be necessary to secure this act. Possibly that could be done before the end of the year. He would like to have that discussed. He would make it as a motion.

THE PRESIDENT understood the motion to be, that the question of establishing a British Columbia branch be referred to the incoming Council.

MR. ROBINSON assented, adding "with power to act."

MR. LeGRAND seconded that motion.

MR. MOUNTAIN said the whole matter of the British Columbia section had been laid before them by Mr. Robinson in a very fair-minded spirit. The tone of his speech was conciliatory and temperate and admirably adapted to the subject. He made this motion that it be turned over to the Council to suggest amendments in the by-laws, if necessary, and then he said that he hoped action would be taken before the end of the year. Of course, that was a long period, but at the same time could amendments be put through between now and the next meeting?

THE PRESIDENT stated the only thing that could be done would be to have them ready for the next meeting.

The motion was then put and carried.

MR. ROBINSON had just one more matter to bring before the meeting.

There was a tendency on the part of politicians in all countries to use the prerogative of appointments as spoils of political battle. He thought that the citizenship of the country at large would approve if the society discouraged that attitude on the part of politicians. If there was anything within the power of the Council that they could do to discourage that attitude it would be probably conferring a boon upon all the citizens of the country, and especially upon engineers who are in the employ of the government.

MR. ROBINSON said in the absence of another to propose his motion he would like to place it in the form of a resolution:—

Resolved, that we, the Canadian Society of Civil Engineers, do heartily endorse the attitude taken by many of the officials of our government towards the matter of separating party politics from the engineering interests of the government, and anything we can do to further such attitude we will enter into with all zest.

MR. JAMIESON was pleased to second that.

MR. DUGGAN was in sympathy with that motion, but he did not think the form in which it was couched was felicitous. The same object was being achieved in another way, by asking the government to create a strong permanent corps. He thought they could eliminate all questions of politics. That had been carefully omitted all through in connection with that matter.

THE PRESIDENT asked if it would not be well to write out that resolution.

MR. ROBINSON thought the sentiment expressed in the resolution met entirely the views of the members, and they could safely trust to the Council or secretary to put it in diplomatic form.

THE PRESIDENT said the resolution would be worded by the secretary.

The motion then carried unanimously.

Proposed Committee on Reinforced Concrete Construction

THE PRESIDENT said there was some correspondence at hand from Mr. Almonte asking that the society form a committee on reinforced concrete construction.

MR. ALMONTE begged to propose that the society appoint a committee to work out specifications for reinforced concrete structures. Canada was one of the countries where reinforced concrete is very largely used. Most European countries and the United States years ago deemed it advisable to get out such specifications containing general rules to ensure safe construction. There was only one public body here in Canada which had issued such a specification, and that was the city of Toronto.

He thought it would be a great benefit to the Dominion if this society took this matter up, and if it were to do so the probability is that its recommendations would be adopted by all public bodies. It would not only ensure safe construction, but avoid the endless multiplicity of specifications

which now prevail in the United States. And it would be a credit to the society to take this matter up now.

MR. MOUNTAIN proposed that it be referred to the incoming Council.

Carried.

Transportation Route Committee

MR. KENNEDY here said that they would all remember about the formation of the General Committee on Transportation. It was sub-divided into committees, of which several have been mentioned, and amongst others was one on transportation routes. It was erected some two years ago in Winnipeg into an independent committee.

Now, the Transportation Committee as a whole has really done almost nothing. The first chairman was Mr. McNab, who resigned after a time, then Mr. Mountain followed, and the president after him, and then he (Mr. Kennedy) was appointed some time ago. The subject seemed to him to be tremendously large when he sat down to consider it and try to do something about it. The president had written an important paper on four transportation routes between Fort William and Montreal, and Mr. Jamieson had also done a good deal personally in the same way. Mr. Coutlee had also done something, but as a committee they had not been able to get together and do much.

Looking over the subject as it stands, transportation routes take in everything from Hudson Straits down to Lake Erie and from Cape Breton to Vancouver Island, and that would be connected again on the Pacific side with the Panama Canal and Liverpool, and the same on this side. Then there is railway transportation as well as water transportation. It comes to be a tremendous subject unless it is more particularly defined than it is now.

Although they got permission from the Council to engage an expert, yet he confessed he hardly saw how the committee, as a volunteer committee, unless there was somebody engaged who would be at it all the time, could make a report which would be worthy of the society and have any weight.

He had grave doubts as to the usefulness of continuing the committee, and if it is continued possibly the constitution of it could be looked over to make it more concentrated. He was not prepared to make a definite recommendation in the matter, but he put it before the meeting so it might be considered.

MR. JAMIESON said, as a member of that Committee on Transportation, he confessed to a great deal of disappointment that they did not succeed in accomplishing what they had set out to do. It was a very difficult matter to deal with, and they have had a great many changes of chairmen, and some members, no doubt, had not been able to give the time and attention to it that was expected. He knew that their president, who was chairman of that committee, devoted a lot of time to it and got out quite an extensive report on the railway end, and some on vessels as well. For himself, he certainly did devote a very large amount of time and considerable expense to it. Month after month he had worked on it from time to time, and he had got his data in such complete shape as would make it very valuable on this question. And yet, to-day they had practically, as a committee, produced nothing.

THE PRESIDENT, after some discussion, suggested that Mr. Jamieson, after going to all the trouble he had, should write a paper for the society.

MR. MOUNTAIN moved that the Committee on Transportation Routes be disbanded.

He thought if the members who had worked on it [illegible] present their information in the shape of a paper it would be a valuable addition to the transactions. If they so desired, they could say the paper was presented more for discussion than as their firm conviction.

The motion to discontinue the committee then carried.

Re Committee on Portland Cement and Concrete

MR. JAMIESON wished to say a word or two in connection with the Committee on Portland Cement and Concrete. Unfortunately, they were not able to report for this meeting. It was something like the question of transportation routes, it covered a great deal of ground and required a great deal of data to be accumulated, and while they had got that very fully, yet, it was a matter of a good deal of work, and will take a good deal of time formulating a report. He had been considering the question of dealing with it in a paper or a lecture to bring out the information they had collected on the question of the effect of sea-water on cement and concrete. That will bring out the matter much more fully than can be done in a report, and then they could make a short report at a later date based on that.

Report of the Gzowski Medal Committee

THE PRESIDENT said he had a report by wire from the different members of the Gzowski Committee. The chairman of that branch was away ill, so that they had to get the views of the different members by wire. They were unanimous in recommending that Mr. R. F. Uniacke be given the Gzowski medal for his paper on "The Little Salmon River Viaduct."

This was confirmed by the meeting unanimously.

Report of Scrutineers

The next business was the report of the scrutineers.

BALLOT FOR SPECIFICATIONS.

The secretary read the report for the ballot for specifitions.

THE PRESIDENT presumed this meeting should instruct the Council that these specifications be printed and distributed.

Carried.

BALLOT FOR AMENDMENT TO BY-LAWS.

The secretary read the report as follows:—

By-law 23.—Ayes, 306. Nays, 126. By-law carried.
By-law 24.—Ayes, 339. Nays, 76. By-law carried.
By-law 51.—Ayes, 306. Nays, 47. By-law carried.
By-law 55.—Ayes, 355. Nays, 30. By-law carried.
By-law 20.—Ayes, 325. Nays, 74. By-law carried.

BALLOT FOR ELECTION OF OFFICERS AND MEMBERS OF COUNCIL.

The secretary read the report as follows:—

President—Phelps Johnston.

Vice-President—F. C. Gamble.

Councillors—District No. 1.—J. M. Fairbairn, W. J. Francis, R. J. Durly.

District No. 2.—F. A. Bowman.
District No. 3.—W. D. Baillairge.
District No. 4.—S. J. Chapleau.
District No. 5.—H. E. T. Haultain.
District No. 6.—W. A. Duff.
District No. 7.—T. H. White.

THE PRESIDENT then declared the foregoing gentlemen elected.

NEW BUSINESS

MR. HARKOM moved that the Council be requested to consider the advisability of forming a Montreal branch to operate on the same lines as other branches already formed.

MR. CROMPTON said, in seconding that motion as an out-of-town member, that it seemed to him there was a feeling, particularly among the out-of-town members, that they were not getting value.

THE PRESIDENT said he understood the motion was that the Council shall give its serious consideration to the question of starting here a Montreal branch.

MR. KENNEDY, in discussing the motion, said he noticed this resolution was put forward by gentlemen who were not members resident in Montreal, and not members of any other branch, and have had no real experience in this matter. He thought it would tend to worse confusion if they were to try to make a Montreal branch here. For the society to legislate at this point that Montreal should erect itself into a branch would be very much the same as if the Quebec Legislature ordered the city of Montreal to widen a street which the city knows much better about itself.

This matter of papers which seemed to be behind the motion, he thought, possibly they had a wrong idea about. They must remember that at the present time the whole country is flooded with technical journals. They had English, French, and above all, American journals, and the members had their own "Canadian Engineer," which was becoming a good engineering paper. (Hear, hear). So, it was practically impossible for a busy engineer to do much more than keep up with the procession, to keep on reading what was coming up. All the best papers of the engineering societies were published in the engineering papers.

They were trying to put upon the Council and the committees what was really the duty of individual members.

He did not think the annual meeting was quite the right place in which to order the members in Montreal to form themselves into a separate branch independently of the Council, because the thing was not workable and would really complicate matters and induce confusion.

Let those members who wanted to write papers write them freely, and not scold too much those who did not write when they themselves are not setting an example.

MR. ROBINSON said in order to relieve this body from the embarrassment which may follow, an accusation of usurping the power of Montreal members to do something which they wish not to do, he would make it a motion that this whole matter be left in the hands of the Council to deal with as they see fit. That the motion be not put as a vote, but simply recognized by the Council as a suggestion.

MR. JAMIESON said it appeared to him that the mover and seconder would probably withdraw their motion as a motion before the society on the promise that the president had already made that the Council would take it up and consider it.

MR. HARKOM said he only asked the Council to consider the advisability of it. He certainly felt that in their hands the matter would receive fair and due attention.

Scale of Engineering Charges

MR. J. S. ARMSTRONG moved the following resolution:—

That the Council be requested to appoint a committee to consider and, if possible, draw up a schedule or scheme of charges for engineering services.

MR. LEOFRED seconded that motion. All the professions, notaries, land surveyors, doctors, have got what they call a minimum charge. This would only refer to the minimum charge, he understood.

THE SECRETARY said that he thought it was in the knowledge of members of the Council that this matter engaged the attention of the Council something like a year ago, and that even the proposer of the tariff scheme himself failed to put up anything that he could satisfy himself with. They had spent some time over it and came to the conclusion that it would utterly fail.

The motion was put to the meeting after some discussion and defeated.

Re Specifications for Steel Water Pipes

THE SECRETARY said a member of the society, Mr. Pitcher, telephoned him just then to say he intended to be here in order to ask that the matter of appointing a committee to consider specifications for steel water pipes be referred to the Council. He now finds he cannot get here. The secretary supposed this matter might be included in the others remitted to the Council.

MR. VAUGHAN moved that it be referred to the Council.

Election of Nominating Committee, Officers and Members of the Council

The next business was the election of a Nominating Committee.

THE SECRETARY said the following were the nominations by the Council for the formation of a Nominating Committee, and the by-laws required that this Nominating Committee shall be elected by the Annual Committee. Suggestions have been received from the branches, who have taken some means to ascertain the views of their members. The suggestion in regard to the local member is that of the local members of the Council. The suggestion for District No. 2 is from the local councillors in the Maritime Provinces.

The following name was suggested as a member of the Nominating Committee for District No. 1, H. M. Jacques.

Adopted unanimously.

THE SECRETARY said District No. 2, which was the Maritime Provinces and the United States, put forth two names, F. W. W. Doan and G. Stead.

On being put to the meeting, Mr. Doan was declared elected.

District No. 3, Province of Quebec, F. X. A. Leofred and R. O. Sweezie.—Mr. Leofred was elected.

District No. 4, Alexander McPhail and James White.—Mr. White was elected.

District No. 5, J. G. Sing.—Elected.

District No. 6, W. L. McKenzie.—Elected.

District No. 7, J. H. Grey and L. G. Robinson.—Mr. Robinson was elected.

Votes of Thanks

MR. MOUNTAIN moved a vote of thanks of this meeting to the railways of the Eastern Passenger Association, to the Montreal Tramways Company, to the Canadian Foundry Company, Limited, and to the Canadian Pacific Railway for courtesies extended to the members in session at this annual meeting.

This was seconded by Mr. Monsarrat and carried unanimously.

MR. McNAB proposed that the Council be requested to convey to the Dominion Conservation Commission the thanks of the society for the valuable copies of the reports of the

commission which were furnished gratis to the members of this society.

This was seconded by Mr. Duff and carried unanimously.

THE PRESIDENT then said if there was no other business to be brought before the meeting he would declare it closed.

The meeting then adjourned.

PETROLEUM.

The annual output of crude petroleum from Canadian oil wells, for 1912, still continues to decline, the production having steadily fallen off during the past five years. Twelve years ago Canada produced about 50 per cent. of the domestic consumption of petroleum and its products, while at the present time not over 5 per cent. of our consumption is derived from Canadian oil wells. The output in 1912 was 243,336 barrels or 8,516,762 gallons, valued at $345,050, as compared with 291,092 barrels or 10,188,219 gallons, valued at $357,073 in 1911. The average price per barrel at Petrolea in 1912 was $141 or considerably higher than the average price in 1911, which was $122⅔.

The price of crude oil increased steadily through the year, rising from a minimum of $1.24 in January to a maximum of $1.65 in the latter part of December.

These statistics of production have been furnished by the Department of Trade and Commerce and represent the quantities of oil on which bounty was paid, the total bounty payments being $127,751.39 in 1912 and $152,823.20 in 1911.

The production in Ontario by districts as furnished by the supervisor of petroleum bounties, was in 1912 as follows in barrels: Lambton, 150,272; Tilbury and Romney, 44,727; Bothwell, 34,486; Dutton, 4,335; and Onondago, 7,115; or a total of 240,935 barrels. This agrees very closely indeed with the production in Ontario on which bounty was paid, viz., 240,657 barrels. In 1911 the production by districts was: Lambton, 184,450; Tilbury and Romney, 48,708; Bothwell, 35,244; Dutton, 6,732; and Onondago, 13,501.

The production in New Brunswick in 1912 was 2,679 barrels, as against 2,461 barrels in 1911 and 1,485 barrels in 1910.

Exports entered as crude mineral oil in 1912 were 18,500 gallons valued at $3,964 and oil refined, 36,945 gallons, valued at $6,147. There was also an export of naphtha and gasoline of 25,791 gallons, valued at $4,261.

The decreased production has been accompanied, particularly during the past two or three years, by a very large increase in imports of petroleum and petroleum products. The total imports of petroleum oils crude and refined in 1912 was 186,787,484 gallons, valued at $11,848,533 in addition to 2,144,006 pounds of wax and candles valued at $119,520. The oil imports included crude oil, 120,082,405 gallons, valued at $3,996,842; refined illuminating oils, 14,748,218 gallons, valued at $1,022,735; gasoline 40,904,598 gallons, valued at $5,347,767; lubricating oils, 6,763,800 gallons, valued at $1,077,712 and other petroleum products 4,288,463 gallons, valued at $413,477.

The total imports in 1911 were 116,892,680 gallons of petroleum oils crude and refined, valued at $6,009,730 and 1,959,787 pounds of wax and candles, valued at $106,424. The oil imports comprised crude oil, 71,653,251 gallons, valued at $2,188,870; refined and illuminating oils, 13,690,962 gallons, valued at $722,403: gasoline, 23,338,773 gallons, valued at $1,976,032; lubricating oils, 5,308,917 gallons, valued at $806,452, and other petroleum products, 2,900,786 gallons, valued at $315,973.

The principal increases in imports have been in crude oil now used so extensively in British Columbia by the railways and in gasoline.

ELECTRICITY IN IRON AND STEEL INDUSTRY.

By J. E. Dalemont.*

The recent development in iron and steel plants has been characterized by two important features, i.e., the large direct consumption of the blast furnace gas in gas engines of large capacities and the direct drive of reversible rolling mills by electric motors.

The average consumption of coke may be estimated to one ton (1,000 kgs.) per ton (1,000 kgs.) of pig iron produced by blast furnace process and the quantity of gas produced is not less than 150,000 cubic feet.

Its average composition is:

CH_4	0.5	to	1.8
H	1.8	to	2.8
CO	21	to	26

Of this quantity about 70,000 cubic feet is used for heating the air required by the blast furnace process and the balance, about 80,000 cubic feet, is usually collected from the top of the furnace and distributed in the boiler room and elsewhere for heating purposes.

In the last ten years, owing to the progress of the gas engine industry, almost all the blast furnace gas is used directly by gas engines for generating power; it is estimated that of the 80,000 cubic feet mentioned before, about 64,000

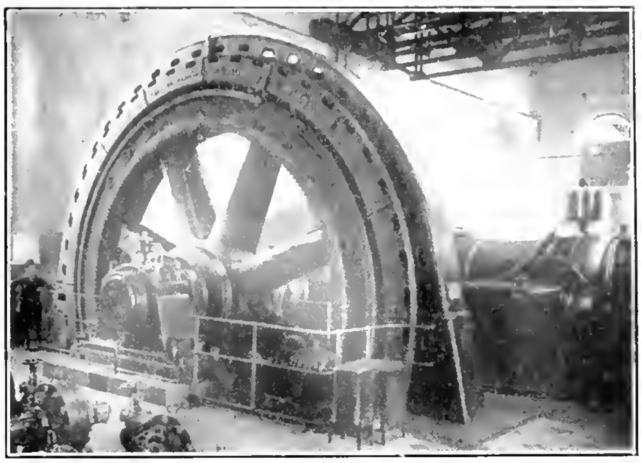


Fig. 1.—Alternator Driven by Gas Engine.

cubic feet are available for power purposes, after making allowance for the operation of the blast furnace accessories.

The advantage of this may be easily understood if we recollect that with the gas engine 28 to 30 per cent. of the calorific energy of the gas is transformed into mechanical energy, while the steam engine does not transform more than 12 per cent.

This explains also the efforts made in the last ten years to bring the gas engine construction to a very high standard. In 1900 the largest engine was not over 100 horse-power and now many engines of 3,000 to 4,000 horse-power have been built and installed, and there are units in operation of 5,000 horse-power each.

The calorific energy remaining in the gas after completion of the iron process in blast furnace practise per ton of iron produced, is approximately 1,700,000 calories for 64,000 cubic feet of gas (referred to before) which is the estimated average to be used in gas engines.

* General Manager, Engineering Works of Canada, Limited.

Some tests made with large units have shown that per kilowatt obtained the consumption of gas by a gas engine of good design is:

3,160 calories at full load
3,770 calories at 3/4 load
4,020 calories at 2/3 load

Comparing this with the steam turbine, using superheated steam of 300 degrees C. at a pressure of 160 lbs. per square inch, the average number of calories required per kilowatt produced may be estimated between 7,500 to 8,500. About 475 kilowatt hours may be generated with the energy remaining in the blast furnace gas, produced per hour and per ton of pig iron. One may easily realize the advantages with higher wages paid for help on this continent, the figures should be somewhat increased.

Owing to the somewhat different industrial and economical conditions, gas engines came, in Europe, into larger use some years before an extended application was made on this continent. The French company, "Société Alsacienne des Constructions Mechaniques," owing to its large experience in mechanical construction, has achieved in this new line a remarkable success, as demonstrated by the numerous installations of complete plants, many of them having a capacity of 10,000 and 15,000 horse-power.

Fig. 1 shows one of the alternators driven by a 94 r.p.m. gas engine, six of which were installed in the mills at Home-

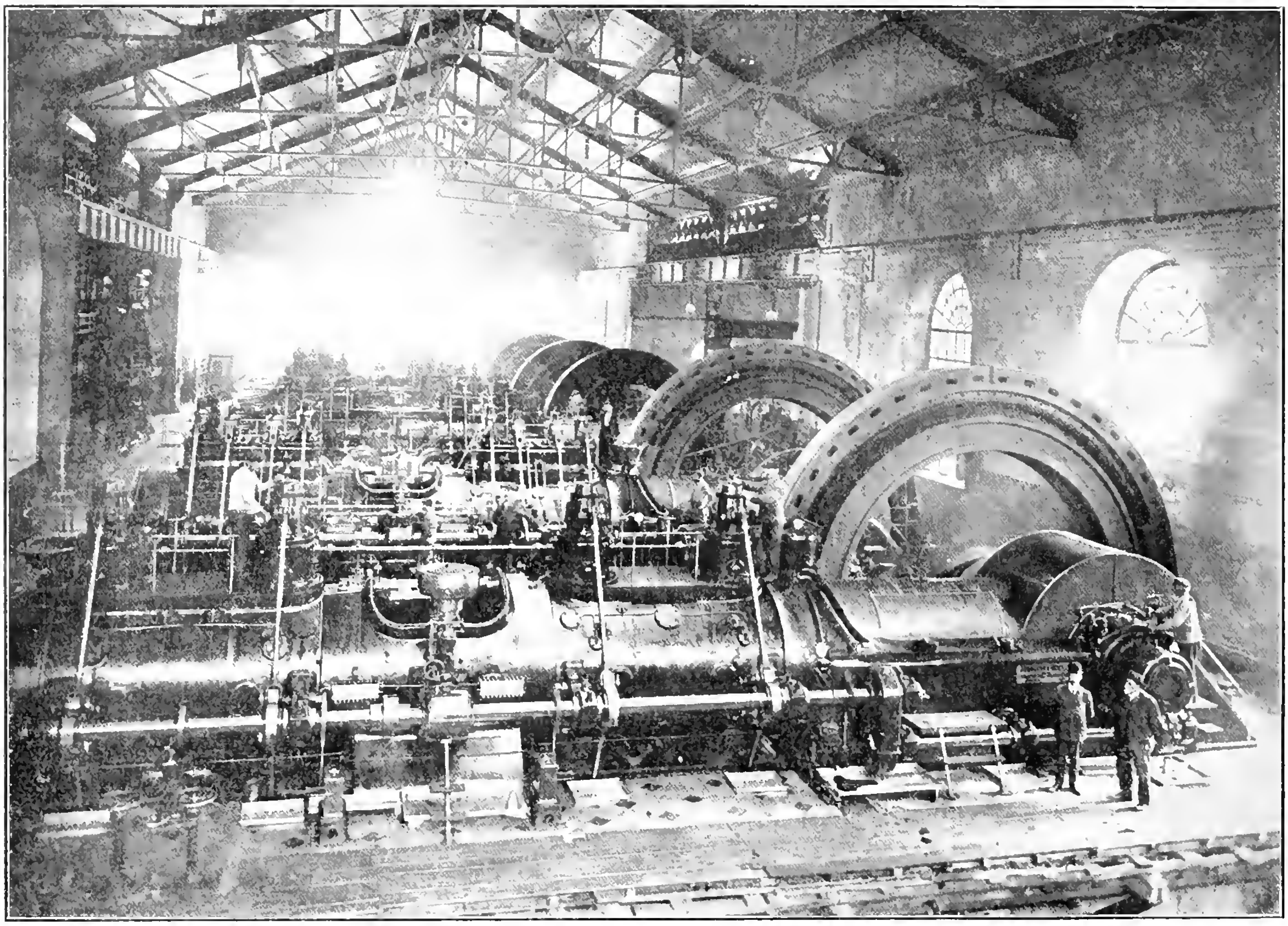


Fig. 2.—Central Station of Steel Plant.

the iron and steel plants have obtained from the new use of the blast furnace gas, generating at a very low cost electric power which is applied for lighting purposes or motors.

Similar results may also be obtained in coal mines by means of gas producers of high efficiency and the use of coal of low selling value. The gas, either drawn from the furnace or gas producers, must be washed out completely by means of special cleaners, as the cleanliness of gas is an absolute necessity for effective operation of the gas engine.

The next most important question is: What will be the total expenses per kilowatt hour at the terminals of the electric machines driven by such a gas engine? This, of course, to a large extent depends upon special conditions, which cannot be easily covered by a general estimate, but we may say that in Europe, in several large plants, the cost of production never exceeded .24 cents. With gas producers this figure is somewhat higher, about .55 cents. Of course, court. The A. C. generators have been built in the Belfort shops of the company.

The gas engines for this special application are built up to 2,000 horse-power, with two cylinders tandem, two and four tact and up to 4,000 horse-power with four cylinders tandem.

It is not intended to give here a complete description of the engines; however, some details of the distribution to the cylinders are shown which will be found interesting.

A sliding valve opens on one side the admission of air, and on the other side the admission of gas, so that gas and air can be mixed in the valve box and then admitted to the cylinders by the admission valve. This valve, as well as the exhaust valve, are operated by means of eccentrics mounted on an auxiliary shaft, which is driven by the main shaft. Its speed is half of the speed of the engine, and obtains its movement from the main shaft by means of conical gears.

The regulator is provided with an adjustment to vary automatically the speed within the limits required.

The regulator changes the composition, i.e., the gas admitted and the compression is reduced at the same time with the load, although the gas is perfectly inflammable, even for the smallest admission at no load. The valves are cooled by water circulation. The ignition can be produced either by a normal circuit at 60-100-220 volts with magnetic breakers or by a "Bosch" magneto with mechanical breakers, placed in duplicate on both sides of the cylinders in order to obtain a complete ignition. The anticipated ignition can be regulated during running.

For starting large engines, the compressed air has given the most satisfactory results. It is used at a pressure of 140 to 230 lbs. per square inch. As soon as the engine starts to run and the first explosion is obtained, the admission of compressed air is automatically suppressed on the corresponding side.

Fig. 2 shows a central station installed recently in a large steel plant by the "Société Alsacienne." The gas motors are fed with blast furnace gas and directly connected to alternating current generators. Frequently the alternators to be driven by gas engines have been built with the stator inside and the rotor outside, in order to increase the flywheel effect.

FEBRUARY PRECIPITATION.

An excess of precipitation occurred during February in Central and Southern British Columbia, Southern Alberta, Eastern Saskatchewan, Western Manitoba, Upper Ontario and the Georgian Bay region, and eastern districts of the Maritime Provinces, elsewhere the average value was not reached. The negative departures were quite marked, particularly in Vancouver Island, B.C., and the lower lake region of Ontario, where the fall was, as a rule, less than half the usual amount.

On the last day of the month the ground was snow covered throughout Canada, except on the British Columbian coast, and the depth was considerably greater than at the close of January. In the interior and north of British Columbia more than five feet of snow was on the ground. A slight covering in the neighborhood of Swift Current increased to a depth of twenty-five inches over Northern Manitoba, and to five and eight in Northern Alberta. The Highlands of Ontario, together with northern districts, were covered by over thirty inches, this being also the case in Eastern Quebec and Cape Breton Island. Good sleighing prevailed in nearly all districts during the greater part of the month.

The following table, included in the report of the Meteorological Office, Toronto, shows the total precipitation of fourteen stations for February, 1913:—

	Depth in inches	Departure from the average of 20 years
Calgary, Alta.	....	....
Edmonton, Alta.	0.60	—0.14
Swift Current, Sask.	0.30	—0.35
Winnipeg, Man.	0.60	—0.09
Port Stanley, Ont.	1.70	—1.28
Toronto, Ont.,	1.17	—1.15
Ottawa, Ont.	2.20	—0.30
Kingston, Ont.	1.50	—0.59
Montreal, Que.	2.80	—0.43
Quebec, Que.	2.90	—0.16
Chatham, N.B.	2.30	—0.49
Halifax, N.S.	3.30	—1.22
Victoria, B.C.	1.90	—1.67
Kamloops, B.C.	1.00	+0.19

WATERWORKS INEFFICIENCY.

Conservation, published by the Commission of Conservation, Ottawa, has written interestingly in regard to waterworks figures which the commission has gathered in Canada. It is as follows:—

Ninety-five and a half million dollars are invested in waterworks systems in Canadian towns and cities. The annual outlay for maintenance, exclusive of interest, amounts to $3,435,199. There are, in all, 5,215 miles of mains in use, and the total daily consumption of water passing through these, reaches 360,477,638 Imperial gallons.

These are the figures obtained by an investigation just completed by the Commission of Conservation, the results of which are being published as a report on the waterworks of Canada. They indicate something of the magnitude of the investments that are placed in Canadian public service utilities. By far the larger number of these plants are owned by the municipalities themselves, but there are a few of the smaller ones that are owned and operated by private individuals or corporations.

A Glimpse at the Details.—An examination of the details going to make up these totals present some interesting conditions. Thus, the estimated cost of supplying water varies from seven cents per 1,000 gallons for the municipalities of Nova Scotia, to 23 cents per 1,000 gallons for those of Saskatchewan, with costs in the other provinces ranging between these extremes.

In Saskatchewan, where the cost of delivery is higher than in any of the other provinces, the amount of water used is much less. In the city of Moose Jaw, for example, the daily consumption rate is only 15 gallons per head of population. All the water is metered and no flat rates are levied. The meter rates range from 10 cents to 25 cents per 100 cu. ft., somewhat below the average for the province. In the matter of meter rates, however, there is an exceedingly wide variation in Saskatchewan. In one small town these rates range from 25 cents to 75 cents per 100 cu. ft.

Waste of Water.—In eastern Canada the consumption rate is more uniform, but there are indications of considerable waste in many cities. Last year an Ontario city employed experts to ascertain the causes of waste. They found some serious leaks in mains, as well as wastage by individual users. The expert engineer, in his report, states that:—

"Water is pumped at the present time at the rate of about 190 Imperial gallons per capita daily. At least three-fourths of this water is wasted without benefit to any one. Some of this wasted water no doubt escapes from leaks in the pipe system, but probably most of it escapes from leaky plumbing fixtures in the houses and shops of the city."

One hundred and ninety gallons of water weigh nearly one ton, so that this city is each and every day in the year, pumping four and a half tons of water for each family of five persons. The average consumer may truthfully say that he is not using that amount of water, but he is paying for that amount and, if of the well-to-do class, prabably for more than that amount.

And it is not unique in this respect. There are very few cities on the North American continent in which enormous water waste cannot be found, and this despite the well-known fact that it is only necessary to install meters to put a stop to it. The Canadian who is really patriotic can not do better than consider carefully this question, particularly as far as it affects his own municipality. It is axiomatic to a waterworks expert that fifty gallons of water per head of population is ample and that—unless water is used for irrigation or similar purposes—all that is pumped over and above that amount is wasted.

CITY WATER WASTE.

There is, as has been often mentioned in this journal, a considerable waste of water in some of our Canadian cities. A report to the council of the city of Ottawa on this subject by a special committee appointed to examine into it, probably partially applies to the state of affairs in many other cities and towns. In Vol. 21, No. 8, August 24th, 1911, of The Canadian Engineer, we published a table regarding the cost of water supply in a number of Canadian municipalities of comparatively small size. It may possibly interest some readers to look this up in connection with the present article

The report reads:—

At the last Council meeting there was referred to this committee the question of water waste in the supply system throughout the city. In order that the committee may be in a position to immediately take up the consideration of this important question, I have prepared certain information which I beg to place before you along with my recommendations in the matter. I have, of necessity, gone into this question in detail so that the seriousness of the existing conditions may be quite apparent.

Rate of Consumption.—During the past year the amount of water pumped each day averaged 17.7 million Imperial gallons. The highest consumption, amounting to 20.6 million gallons, occurred on Saturday, July 13th, and the lowest consumption, amounting to 15.0 million gallons, occurred on Sunday, October 27th. On Wednesday, February 12th, of this year, the consumption amounted to 19.7 million gallons, and the daily average for the month of January amounted to 18.0 million gallons.

Pumping Capacity.—The present pumping capacity is actually about 30 million gallons per day, made up as follows:

Pump No. 1	3	million
2	3	"
3	3	"
4	5	"
5 and 6	8	"
6 and 7	8	"
Total	30	gallons per day

Of this amount 16 million gallons is accounted for by the two units, five and six, and seven and eight, most recently installed. The water wheels to operate these four pumps are in one wheel case so that when an accident occurs, as in October last, to any part of these water wheels fully one-half of the available pumping capacity is thrown out of business. This leaves the city with 14 million gallons available for its use, whereas last year the consumption averaged 17.7 million gallons per day, and as stated previously, reached as high as 20.6 million gallons on Saturday, July 13th last. Furthermore, at certain periods of the day, notably between 9 a.m. and noon, the rate of pumping would rise as high as 23 million gallons per day. Even with one of the large units being out of business, the capacity would be reduced to 22 million gallons per day. Any break-down occurring to any one of the old pumps would not materially affect the output as they are in smaller units and operate independent of each other.

It will plainly be seen that additional pumping capacity is urgently required unless an immediate and vigorous policy of waste prevention is pursued.

Consumption per Capita.—The rate per capita during 1912 was 185 gallons per day. The highest it ever reached during any year was 192 gallons per day during 1907. On February 12th last, however, the consumption amounted to 206 gallons per capita, while on Sunday, the 9th of February, it amounted to 194 gallons.

The pumping station records show that from midnight to 3 a.m. the amount of water pumped is about 85 per cent. of the average rate of pumping for the 24 hours. In other words, while the average daily consumption during 1912 was 17.7 million gallons, the rate of pumping during the night amounted to 15 million gallons per day. A very small portion of the water pumped at night represents legitimate use, nearly all being waste, and this waste so shown can be safely assumed to go on to a large extent throughout the 24 hours. If no such waste existed, then the night rate of pumping would be a small fraction of the average rate of pumping, certainly not more than 10 per cent. as against 80 to 90 per cent. as at present.

Let us consider the rate of pumping for February 12th last. The total quantity pumped that day was 19.7 million gallons, or a per capita rate of 206 gallons daily. From midnight to 3 a.m., the rate of pumping was 87 per cent. of the daily average. In other words, the quantity pumped per capita during the whole 24 hours was 206 gallons, the rate of pumping from midnight to 3 a.m. was 179 gallons per day. The figures for last Sunday, the 16th, are as follows:—

Total quantity pumped	18.3 million gals.
Quantity per capita per 24 hrs.	191 gals.
Rate from midnight to 3 a.m.	173 "

or the night rate was 90 per cent. of the average daily rate.

It is rather striking to observe that the consumption per capita per day increased from 101 gallons in 1889 to 168 gallons in 1893, an increase of 67 gallons per capita per day in four years time. I have so far been unable to find any satisfactory reason for this sudden increase.

At least 75 per cent. of this daily average is wasted without benefit to anyone. Both Sir Alexander Binnie and Mr. Allen Hazen state that 75 per cent. is wasted, and for this statement Mr. Hazen gives the following reason:—

A. There are no great manufacturing uses of water; manufacturing establishments are mainly located upon the river and obtain their water from it for manufacturing purposes and do not draw from the city works.

B. The experience of other cities which probably need to use, and do use, as much water as is used in Ottawa where systematic study has been made of the waste of water and intelligent efforts have been made to cut off such waste as far as possible, indicate that the amount actually used is not more than one-fourth as great as the amount pumped in Ottawa.

C. The night rate of pumping indicates this. Most of the actual use of water is in the day time. There is no reason why any large quantity of water should be used during midnight and 3 a.m.

From these statements, not more than 50 gallons per capita daily should be actually necessary.

Effect of Waste of Water upon the System.—The effect of allowing this enormous quantity of water to waste is that the whole waterworks system must be built larger than would otherwise be necessary. The distribution mains must be larger and the pumps must be of greater capacity. If the water is purified, the purification plant must be made larger in size and if the supply comes from a distance, such as is proposed by bringing the water from the Gatineau Hills, large additional storage must be provided for besides the enormous cost of laying main supply pipes so much larger in diameter.

No amount of reasoning can justify the necessity of this useless waste. No one derives the slightest benefit from it,

not even the oft repeated statement that it serves to flush out the sewers, because it is discharged at a steady rate, and for flushing purposes is of little value. For the benefit of all concerned it is absolutely essential that this waste should be reduced as far as possible within reasonable limits without incurring any greater expense in detecting and rectifying the waste than would be represented by the waste itself.

Waste Detection in the Past.—Until last year, practically no means were taken to to detect waste. Last summer the Pitometer Survey was carried out to detect leaks in the distribution mains, but barely one-half of the city area was covered. Leaks amounting to 4.4 million gallons per day were discovered, but this does not mean that the daily pumpage was reduced by that amount, as some of it disappeared in other leaks where the pressure was largely increased, due to the stopping of these leaks already found by the survey.

Meters.—Ottawa is practically an unmetered city as the following table will show:—

City	Year	Population	Consumption in million gallons Max.	Min.	Aver.	Gallons per capita	No. of Services	No. of Meters	Per Cent. metered	Per Cent. of consumpt. metered
Ottawa	1912	95,575	20.6	15.0	17.7	185	22,278	41	0.2	3.9
Springfield	1911	90,527	12.4	5.5	8.8	96	12,985	8,414	65	48
Lawrence	1909	81,000	....	....	3.0	44	7,416	6,633	90	59
Hamilton	1911	82,095	....	....	8.03	98	.....	....	...	....
St. John, N.B.	1911	46,016	....	....	11.5	250	6,457	193	3.2	14.5
Louisville	1910	201,000	....	....	18.4	92	35,159	2,847	8.1	33
Vancouver	1911	112,240	....	....	18.0	160	24,861	1,638	15	....

From the report made by the Pitometer Survey firm, published on page 1037 of the 1912 council minutes, you will observe that most of the leaks occur in the services and distribution mains, but that the house fixtures are not so bad as they are generally found in other cities. The following table will show what can be done in the way of waste prevention combined with metering:—

City.	Year.	Per cent. of meters.	Per capita daily consumtion gals.	Reduction per capita per day, gals.
Cleveland, O.,	1900	6	169	70
	1908	92	99	
Grand Rapids	1899	0	174	39
	1908	34	135	
Richmond, Va.	1890	1	168	55
	1907	53	113	
Milwaukee, Wis.	1891	40	112	32
	1903	90	80	
New Bedford, Mass.	1899	12	107	23
	1908	32	84	
Hartford, Conn.	1900	6	85	26
	1907	98	59	
Minneapolis, Minn.	1899	22	94	36
	1908	75	58	
Lowell, Mass.	1893	28	83	25
	1907	73	58	

How is the Water Wasted?—Water waste is divided into two heads:

a. Unknown.
b. Wilful.

In the first class we have all the leaks in the distribution mains and house services. These are known to exist, but are not visible until further examination has been made. Services that have been abandoned are generally a prolific source of waste, especially as they generally get frozen and in the spring of the year burst and continue running to waste unnoticed in many cases because of the seamy, rocky nature of the ground through which a large proportion of the services in this city is laid.

The wilful class of waste, as far [illegible] my observation [illegible] is extremely great throughout the city. By wilful waste I mean everything that can come under the term "of knowingly letting water run without anyone deriving any benefit from it."

During the first half of this month, as stated previously, the night flow averaged 85 to 91 per cent. of the daily flow. When one considers the day pressure is 90 lbs. at the pumping station, as against 80 lbs. at night, then the night flow would still be greater if the pressures were the same throughout the 24 hours. On Sundays the pumpage is only 5 per cent. less than on week days. Large quantities are wasted daily by the continued running of taps to keep them from freezing. This can be easily observed from the daily quantity pumped, as on very cold days the consumption jumps away up; for example, on February 15th, the minimum temperature was 4 degrees above zero and the consumption per capita was 190 gallons, while on February 12th, the minimum temperature was 10 degrees below zero and the consumption per capita was 206 gallons. A few examples of wilful waste may prove interesting.

A building in the city has an electric booster pump in the basement. This pump is kept running for eight hours each day, pumping water into a tank on the roof. This tank is provided with an overflow which is nearly always running to waste.

In an engineering work the water is kept running night and day in connection with a hydraulic air compressor, simply, as they tell you, to keep the pipes from freezing.

Suppression of Waste.—There are two methods which may be used for the suppression of waste:

(a) The examination of the entire distribution system, including all mains, services and internal plumbing fixtures. This can be done by certain methods which have only been developed within the last two years. Much of this waste can be located and eliminated by the use of the Pitometer, the aquaphone, etc.

(b) The introduction generally of the meter system. The wilful waste of water is very largely due to the lack of a meter system. Not only would the services be kept from running when not in use, but any defective plumbing would be immediately repaired. Again, a supply of water should be placed on a strict business footing, and so do away with such absurd cases as the following, quoted from the Pitometer Survey report:—

"The gas works on King Edward Avenue were using a large quantity of water, so a separate gauging was made for two days, and they were found to have a mean consumption of 125,000 gallons per day. At present they pay a flat rate of $245 per year, but this quantity of water at the minimum meter rate of 6 cents per 1,000 gallons would produce a revenue of $2,737.50."

The St. Lawrence Pulp and Paper Mill, on Montreal Street, was found to be using a large quantity of water. They were tested several times and found to be drawing at rates varying from 100,000 to 175,000 gallons per day.

They run both day and night and as they only pay a flat rate of $27 per year there is evidently a big loss of revenue here.

J. B. Booth & Company pay a flat rate of $1,636.86. We made a prolonged test of this plant and found that one of their services, if metered, would produce more revenue than this. This service had a steady flow of 93,500 gallons per 24 hours, which would produce, at the minimum meter rate of 6 cents per 1,000 gallons, a revenue of $2,047 per year.

Conclusions.—From the foregoing it will be clearly observed that immediate action must be taken to either increase the pumping capacity (and incidentally enlarge the distribution system) or pursue a vigorous policy of waste reduction. Undoubtedly the policy to pursue is that of waste reduction, and this is strengthened by the fact that, as the future supply for this city is likely to come from the Gatineau Hills the installing of additional pumps, which could only be of service for three years at the most, would be an unprofitable investment, and cost a great deal more than is necessary to spend on waste reduction. To be in a reasonably safe position before the warm weather comes in, it is quite apparent that immediate action must be taken.

Recommendations.—I cannot too strongly advise your committee to pursue a policy of waste prevention in preference to that of increasing the pumping capacity and enlarging the distribution mains. I submit the following recommendations for your consideration:—

1. That the city purchase two pitometer instruments and employ the necessary water survey force.

This recommendation is already in force in a large number of American cities, and also in Toronto and Montreal, where excellent work is being done. The city can be divided into districts, and by means of these instruments the flow can be ascertained from time to time, and any excessive flow can be readily observed and means taken to locate any defects which may cause same and have it repaired. These instruments can also be used to determine the pump slippage.

An appropriation amounting to $7,000 has been placed in this year's estimates for this work.

If it is decided to purchase two pitometers, then one of the pitometer survey people should be brought here for about a month to break in an assistant who will be kept on the staff for this purpose.

2. That all business premises be metered. This should include meters on all elevators, syphons, beer pumps, booster pumps, etc. That is, every service outside of an ordinary dwelling house should be metered.

3. That all public services be metered, including all buildings, parks, etc. Also, that a meter should be placed on all government services.

4. That an efficient force be maintained to carry out a thorough inspection of all pumping fixtures on all premises and dwelling houses.

5. That detailed plans be made of all the existing mains throughout the entire city.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.

The annual convention of the American Railway Engineering Association will be held at Chicago, March 18th to 21st: E. W. Fritch, 900 S. Michigan Avenue, Chicago, Ill.

TEST OF WIRE ROPE FASTENINGS.*

By C. W. Hubbell.

A ⅝-in., six-strand plow-steel cable was bent around a thimble and the ends secured to the standing part by a standard ⅝-in. Crosby clip of the U-bolt type, with the nuts drawn as tightly as possible by a 12-in. wrench. The cable slipped under a load of 8,360 lb. In a second test with a new clip tightened with a 24-in. wrench, the cable slipped at a load of 10,020 lb., and after the nuts were again tightened, slipped at 12,380 lb. In a third test made with two new clips, the nuts were tightened under a load of 6,000 lb. with a 12-in. wrench, and the load was increased to 21,710 lb., which broke the cable where it was in contact with the lower U-bolt. As the rated ultimate strength of the cable was 36,000 lb., it was thought to have been weakened by the distortion under the U-bolt, which was set in contact with the standing part, while the head took bearing on the free end. It was assumed that in practice the head of the clip should always be placed on the standing part of the cable and the U-bolt on the free end.

A 95-lb. cast-iron clamp, 33½ in. long, made in two pieces, with grooves fluted to receive the cable, and connected by five 1-in. bolts having a theoretical holding power of 19,500 lb., was placed on a 2-in. seven-strand galvanized steel-wire cable. The bolts were drawn as tight as possible by one man with an 18-in. wrench, and the cable slipped under a load of 12,000 lb. The nuts were tightened by one man with a 30-in. wrench, and a slip occurred under a load of 12,500 lb. The nuts were again tightened, and the third slip occurred under a load of 16,500 lb. The clamp was removed and replaced on the cable in a new position, and the nuts tightened by two men with a 30-in. wrench. The cable slipped under a load of 17,800 lb., and in successive tests under 12,700 and 15,000 lb. When tightened with three men on the same wrench, turning each nut from one-eighth to three-eighths of a revolution, the cable slipped at a load of 19,300 lb. In the last test the groove in the clamps had a diameter of two inches, permitting the cable to rest on the bottom of the groove.

A lighter clamp of different design had a groove 1¾ in. in diameter, designed to develop a wedge action increasing the bolt pressure when the clamps were forced together and the cable distorted enough to bear on the bottom of the groove. The clamp was 12 in. long, weighed 47 lb., was provided with five ¾-in. bolts and had a theoretical ultimate strength of 22,650 lb. for each half. The bolts were fastened by one man with a 24-in. wrench and no slip was apparent under a 10,000-lb. load. The nuts were tightened and the load increased to 20,900 lb. without apparent slip. The clamp was removed and found practically uninjured.

It was concluded that, first, where more than one clamp is necessary they should be placed as close together as possible, in order that the necessary adjustment of cables to bring them all into action shall be as light as possible; second, the clamp bolts should be tightened from time to time as the load is applied; third, the safe holding power of a cable clamp may be taken at about 3,750 lb. per sq. in. or area of the bolts which secure the two halves of the clamp.

*Abstract of address presented to to Philippine Society of Civil Engineers.

COAST TO COAST.

Ottawa, Ont.—Canada's mineral production last year was valued at $133,127,489, an increase of $29,906,405, the highest on record, or twenty-nine per cent. greater than the previous year. There was an increased output in the value of every mineral and in the quantity of all but silver, which decreased two per cent. Ontario still leads with a total production of $51,023,134.

Edmonton, Alta.—Seven hundred and thirty-one new companies, with a capitalization of $91,351,883 were incorporated in Alberta last year, as compared with 573, with a capitalization of $72,455,100 during 1911. Since the incorporation of the province there have been 2,300 companies incorporated in the province, with an aggregate capital stock of $267,304,508.

Ottawa, Ont.—An agreement has been reached between the Algoma Steel Company and the government in regard to the duty rebate made to the Algoma Steel Company on 75,000 tons of rails imported into Canada last summer. The capital were allowed a refund of half duty on 50,000 tons for the G.T.R. and 25,000 tons for the C.P.R. Hon. Frank Cochrane pointed out that two big railways have 500 miles graded and ready for rails which they cannot get, and which the company say they cannot supply at such short notice.

Fredericton, N.B.—A demand in the form of a petition signed by 5,000 people in all parts of the province of New Brunswick, asking for better roads, has been presented to the government by the Good Roads Association. The premier said that, while he did not agree with the idea of building the trunk roads outlined in the Good Roads Association programme, it was the aim of the government to expend $100,000 a year on fixing the "bad spots." He also suggested that a highway engineer be appointed to make specifications for the repair and improvement of these bad spots, so that in a few years the condition of the highways throughout the province would be improved.

Edmonton, Alta.—Landscape Architect Morell has designed a civic centre for Edmonton. Property owners of this land proposed by Architect Morell in his scheme have agreed to sell it to the city at a cost of $2,567,000, to be paid in forty-year debentures bearing five per cent. interest. The commissioners, in reporting on the matter, declared that in their opinion this was the logical location for a civic centre, but that the time is not opportune for the city to invest two and a half millions in a project of this kind. They therefore recommended that the promoters of the scheme take the matter up again at a later date, and submit more reasonable prices.

PERSONAL.

SIR JOHN JACKSON, the well-known engineer and contractor, of London, is making a tour of Canada.

J. H. LYONS, who was for some time employed at the filtration plant at Toronto Island, has accepted a position with the National Paving Company, Regina. He will assume his new duties at once.

J. W. TURNER, former superintendent of waterworks of the city of Strathcona, has, since the amalgamation of Edmonton and Strathcona, been appointed superintendent of waterworks for the Amalgamated cities.

MASON H. BAKER, B.A.Sc., D.L.S., A.M.Can.Soc. C.E., graduate of the Faculty of Applied Science, Toronto University, in 1906, has resigned his position as city engineer of St. Thomas to accept a similar position in Prince Albert, Sask.

MR. R. H. MERRIMAN has resigned his position with the B. Greening Wire Company as regards active connection with the firm. Mr. Merriman, it is understood, has decided to go into the agency business. He still retains his financial interest with the company.

PHILIP J. DUFF, A.M.Can.Soc.C.E., had joined the staff of George F. Hardy, consulting engineer, 309 Broadway, New York. Mr. Duff has recently completed the work on the construction of a new thirty-ton sulphate pulp mill for the Dryden Timber and Power Company, Limited, of Dryden, Ont.

MR. J. S. DOBIE, B.A.Sc., graduate in civil engineering of Toronto University in 1895, was elected president of the Ontario Land Surveyors' Association at their annual convention held recently. Mr. J. W. Fitzgerald, of Peterborough, was elected vice-president and Mr. L. V. Rorke re-elected secretary-treasurer.

MR. WILLIAM H. CONNELL, Assoc.M.Am.Soc.C.E., Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa., on March 4th delivered an illustrated lecture on "Organization of Municipal Highway Departments," before the graduate students in Highway Engineering at Columbia University.

MR. A. A. KINGHORN, B.A.Sc., of the University of Toronto, who has been for seven years in the Works Department of Toronto, and is at present superintendent of the construction of roadways, will sever his connection with this department on March 22, to take a position as manager of the Asphaltic Concrete Company of Toronto, Limited.

H. VICTOR BRAYLEY, who for some time past has been connected with the Transcontinental Railway at Ottawa, has accepted the position of general manager for Gunn, Richards & Company, New York and Boston, whose business is that of efficiency engineers. Mr. Brayley has opened a temporary office in Ottawa for two or three months before moving the Canadian head office to Montreal. Mr. Brayley has been secretary of the Ottawa branch of the Canadian Society of Civil Engineers for three years.

SASKATCHEWAN LAND SURVEYORS.

The annual meeting of the Saskatchewan Land Surveyors was held recently at Regina. The feature of the meeting was a paper on "The Selection of Bridge Sites," by A. P. Linton, B.A., B.Sc., assistant chief engineer of the Department of Public Works. Another excellent paper, but one of a more technical nature, was read by E. H. Phillips, D.L.S. and S.L.S., district surveyor and engineer. Cyrus Carroll, one of the oldest surveyors in the province, was made a life member of the association.

CANADIAN MINING INSTITUTE.

The 15th annual meeting of the Canadian Mining Institute was held at Ottawa recently, about 250 delegates from every part of Canada being in attendance.

The meeting was opened by H.R.H. the Duke of Connaught, who referred to the vast importance of the mining industry in the Dominion, which was, he felt sure, merely on the threshold of future possibilities.

Dr. E. A. Barton was elected president, Mr. Thos. Coutley 1st vice-president and Mr. G. G. S. Lindsay 2nd vice-president.

THE IRON AND STEEL INSTITUTE.

The Iron and Steel Institute, London, will hold its annual meeting at the Institution of Mechanical Engineers, Westminster, on May 1 and 2. At this meeting the Bessemer gold medal will be awarded to Adolphe Greiner, general director of the Societé Cockerill, Seraing, vice-president of the institute. The annual dinner will be held at the Hotel Cecil on May 1.

THE AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.

The fourth annual meeting of this society was held in the United Engineering Societies Building, New York City. The following officers were elected: President, Mr. H. J. Cole: 1st vice-president, Mr. E. Wigmann: 2nd vice-president, Mr. Geo. T. Clark.

The evening session was held at 8 o'clock and was opened with an address by the incoming president, Mr. Howard J. Cole, of Montclair, N.J. Mr. Edward F. Croker, ex-chief of the New York Fire Department and president of the Croker National Fire Prevention Engineering Company of New York City, delivered an illustrated lecture on "Fire, Its Effects and Its Prevention."

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Dècary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, P. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, March 20, 1913 Contents of this issue on page 467

The Canadian Engineer

An Engineering Weekly

THE GARRISON CREEK STORM OVERFLOW SEWER IN THE CITY OF TORONTO.

By RAY R. KNIGHT, C.E.*

The occurrence and recurrence of flooding during heavy rain-storms, due to the inadequate provision of sewers in many parts of Toronto, necessitated a complete system of storm relief sewers. The sewer department of the city engineer's office took the matter up and a scheme was laid down and estimates provided for the purpose of putting a by-law before the ratepayers on January 1st, 1911.

The scheme, which has been partly carried out, follows mainly the lines of the original lay-out. Some deviations, however, were found advisable when details and construction matters were gone into.

The sewerage of Toronto is on the combined system. The general topography of the city is a steadily rising, fairly even surface from Lake Ontario at the south to the ridge about 2½ miles north. The surface is intersected at intervals by natural creeks running from north to south in more or less direct lines, the notable exception being Rosedale Ravine, which follows a southeasterly course to the Don. Steps were not taken in the past to reserve, for purposes of main sewers, these natural creeks, excepting the Garrison Creek and Rosedale Ravine; the general sewerage scheme consisted of a number of sewers flowing into the lake and bay along streets running north and south. The Garrison Creek sewer, however, provided a good example of the treatment which could have been adopted in other parts of the city, with King, Queen, College and Bloor Streets as intersecting parallels. The Garrison Creek sewer is, at the present time, inadequate for the removal of the storm water from the

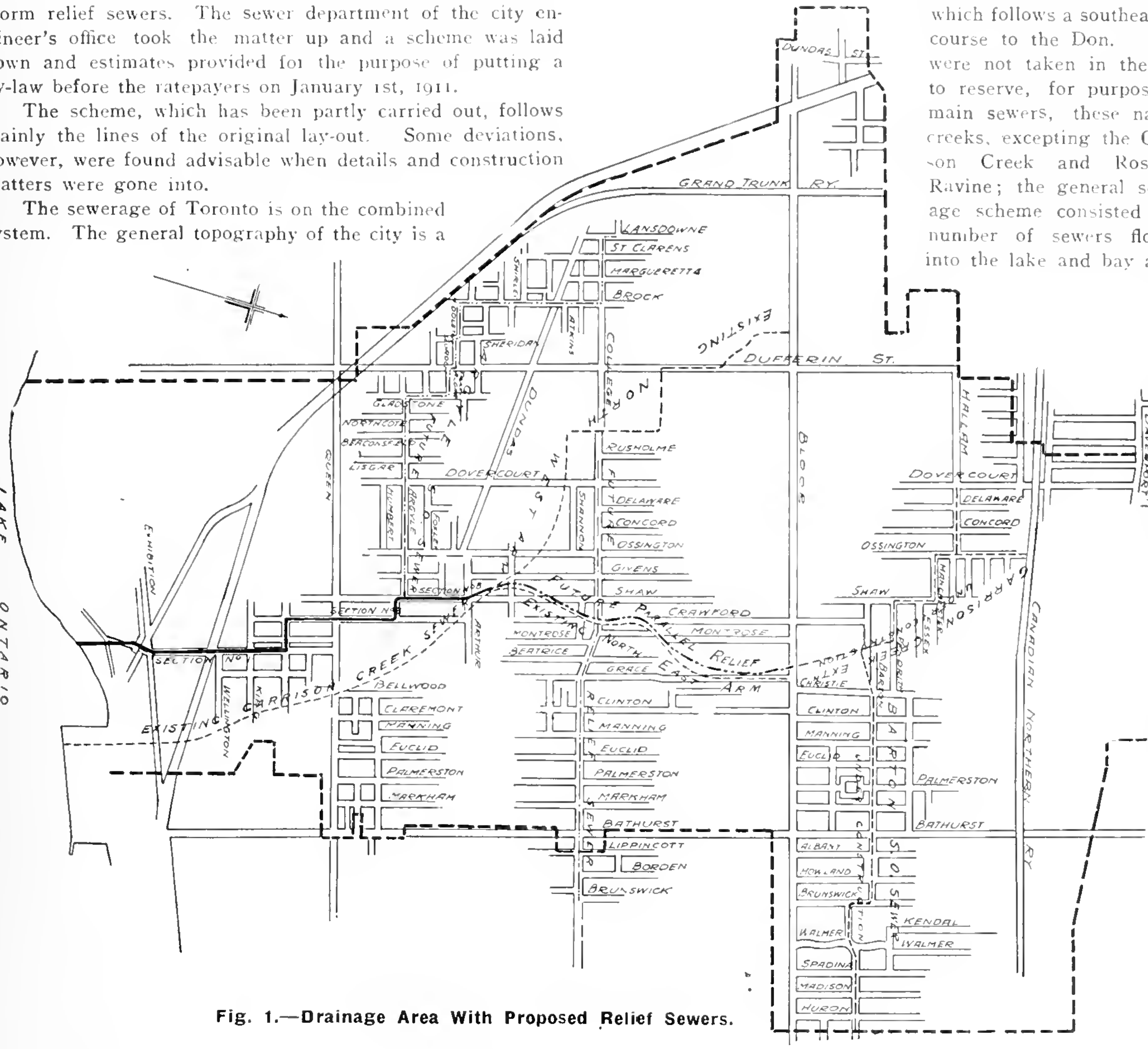


Fig. 1.—Drainage Area With Proposed Relief Sewers.

* Chief designing engineer, Sewer Department, Toronto. Since writing this article Mr. Knight has gone to Fort William, Ont., as city engineer.

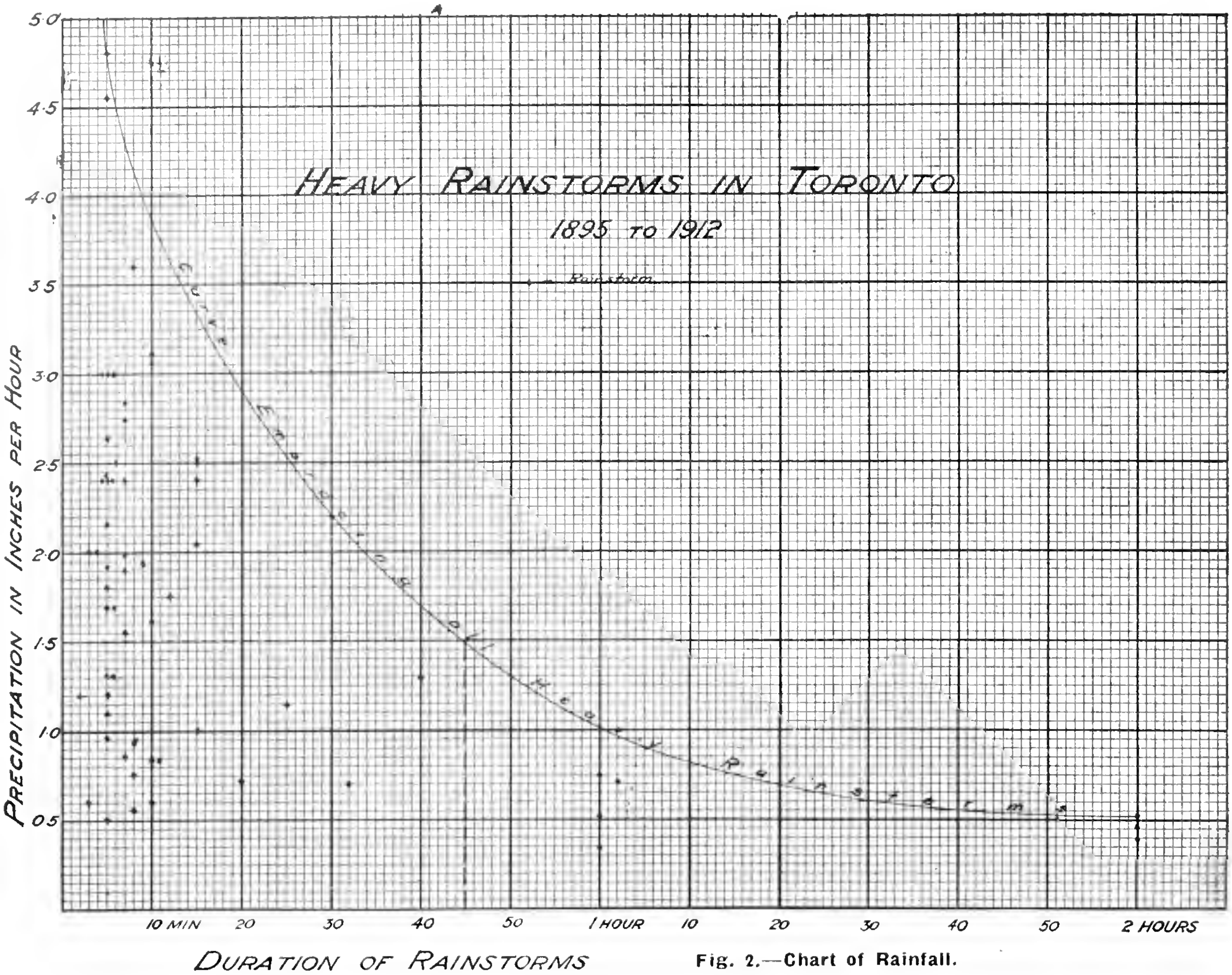


Fig. 2.—Chart of Rainfall.

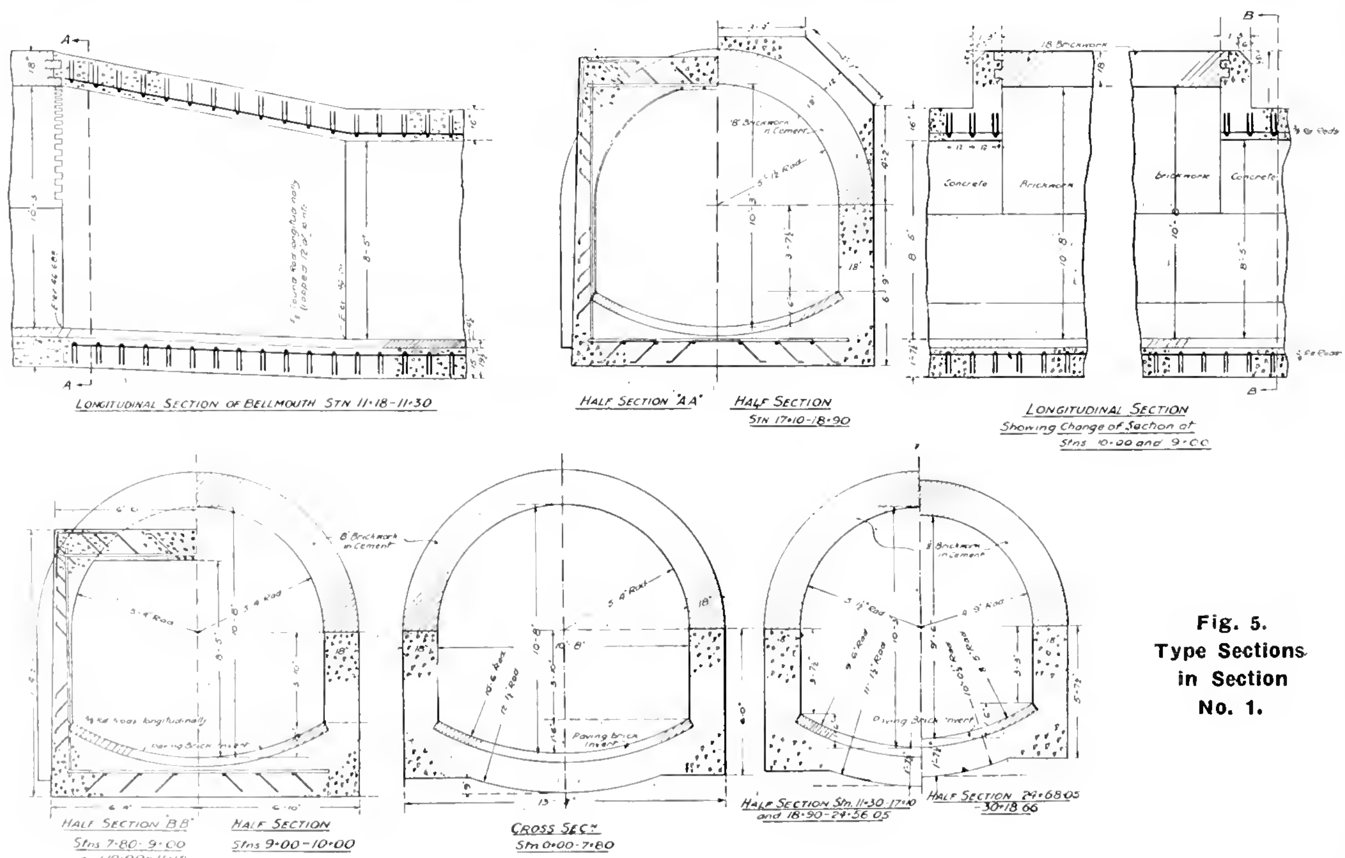


Fig. 5. Type Sections in Section No. 1.

drainage area which has from time to time been extending both northerly and westerly. The outcome being the backing up and flooding of the parallel intercepting sewers, themselves much overtaxed, and the consequent flooding of tributary sewers.

Relief had to be provided before the northerly areas were developed and sewered. It was, therefore, decided to relieve the Garrison Creek sewer at its bifurcation to the northeast and northwest, just north of Arthur Street.

It is the intention of this article to describe the design of this relief sewer, called the main Garrison Creek storm overflow sewers. Sections 1, 2 and 3.

In order to design the relief sewer the following particulars had to be ascertained:—

(1) The existing and probable drainage area.

(2) The locations, elevations and drainage areas of parallel intercepting sewers.

(3) The rate of precipitation.

(4) The rate of absorption, etc.

(5) The probable discharge due to heavy rainstorms.

Drainage Area.—Fig. 1 shows the drainage area with the proposed relief sewers.

Rate of Precipitation.—In order to fix upon a rate of rainfall for which provision would be necessary, the diagram shown in Fig. 2 was prepared. The heavy rainstorms since 1895 are plotted by "diamonds" on this chart, and a curve including all drawn in. It was found that 45 minutes was a fair average for concentration in the intercepting parallels, and that being the case, reference to the chart will show that a rate of 1½ inches per hour is indicated on the curve drawn. This rate was taken in all calculations for the storm sewers.

Rate of Absorption.—The rate of absorption was fixed arbitrarily for certain areas of the city from general knowledge of the localities, based upon a series of actual surveys, made for the purpose of ascertaining the proportional relation of impervious to pervious areas. The result of these surveys is given below:—

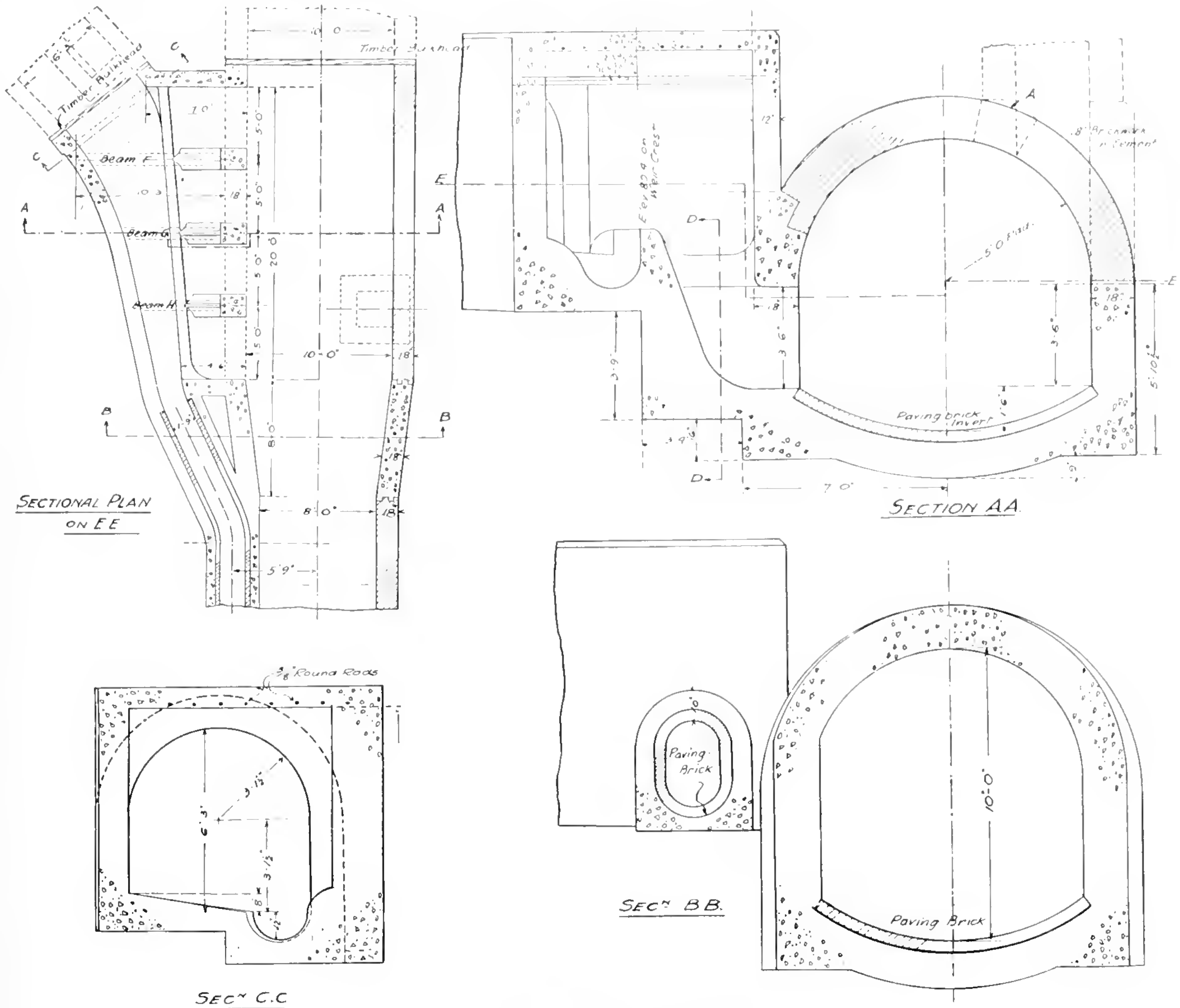


Fig. 8.—Weir Chamber, Argyle Street.

Impervious Areas—Toronto.

Population per acre.	Remarks.	Impervious area.
19	Open, good property	.19
24	Shops and old dwellings	.43
25	Good new property	.21
30	Good new property	.19
30	Good property, small gardens	.37
36	Good new property	.37
37	Good new property	.36
42	Good new property, large gardens	.26
50	Ordinary terrace houses	.36
55	Good new property	.37
60	Good new property	.33
65	Old terrace houses	.43

	Acres	Rainfall in C. F. S.	Sub Totals	Summation of Rainfall	Remarks
Bloor Street East	120	61.47			
" " West	238	119.29			
Garrison Creek Extension	1338	668.00		848.76	Total at Bloor St
College Street East	169	119.68			
" " West	166	95.92			
Montrose Av & Crawford St	29	16.50		1080.86	
College St to Junction N.E.& N.W. Arms	18	11.67		1092.53	Total for N E Arm
N W. Arm	285	153.23		1245.76	
Existing Garrison Creek sewer to take out			300.00	945.76	Total at end of Sec 3 M.G.C.
Shaw Street (S of Arthur St)	7	4.66		950.42	
Argyle S. O. Sewer	375	237.89		1188.31	" " " Sec 2 "
Queen Street West	106	73.43		1261.74	
Defoe "	7	5.90		1267.64	" " sec 1 "
King Street	36	29.26		1296.90	" " Lake Ontario

Fig. 3.

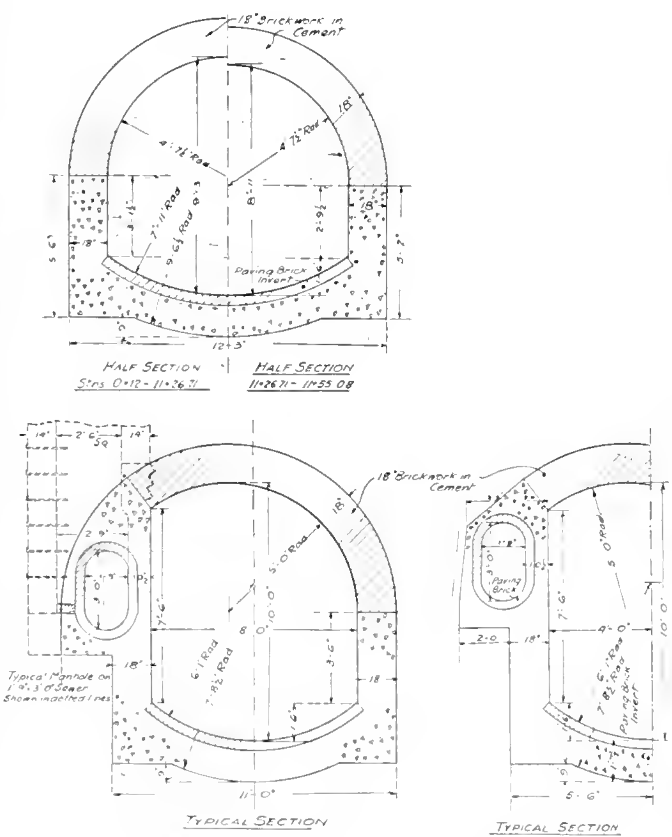


Fig. 6.—Junction Chamber, Section No. 2.

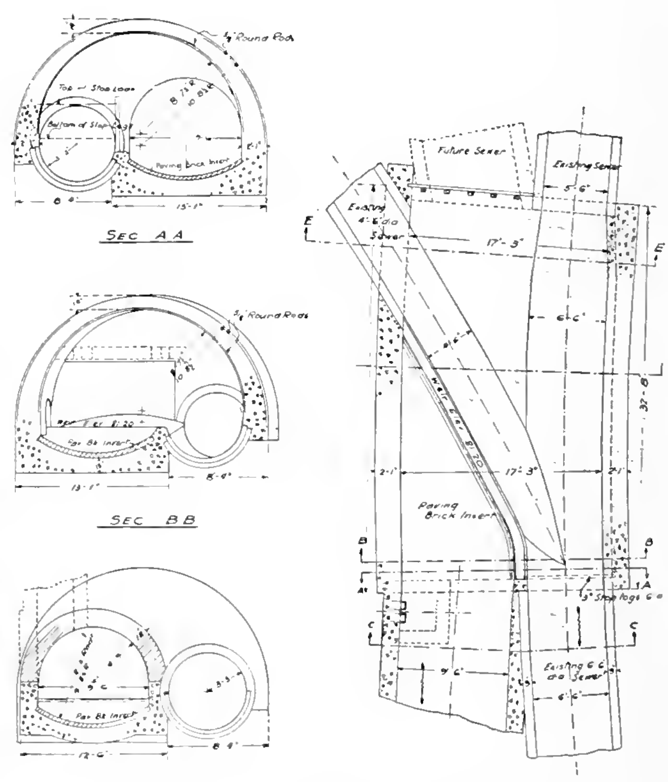
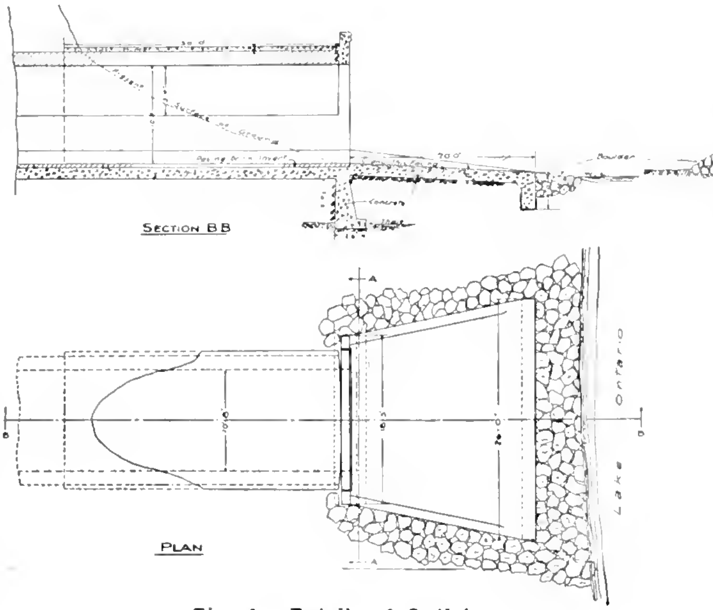


Fig. 9. Junction Chamber, Section No. 3.

Discharge Due to One and One-half Inches Rainfall.—The diagram shown in Fig. 3 was prepared showing the discharge in cubic feet per second at all points along the line of the proposed storm relief sewer, due to a rainfall of 1½



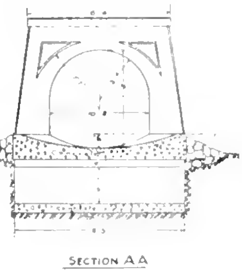
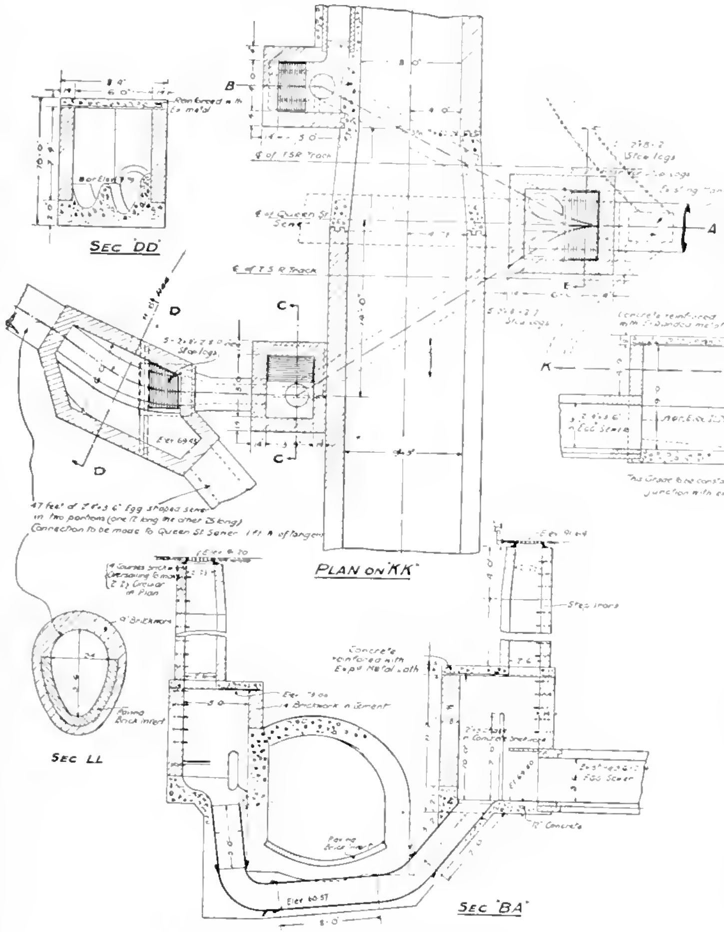


Fig. 4.—Details of Outlet.



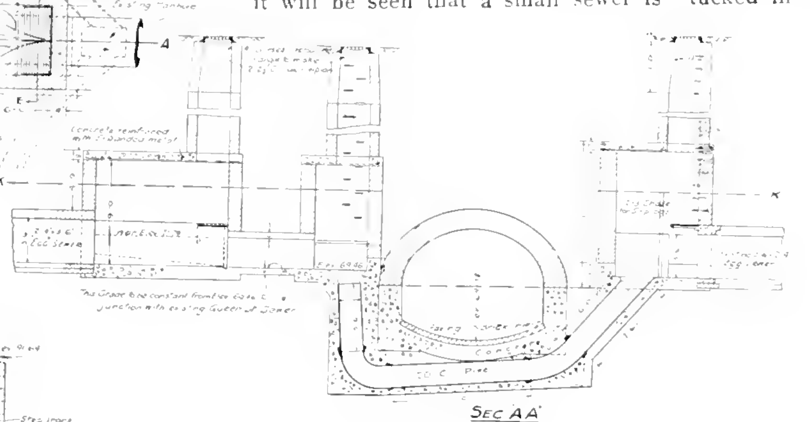


Fig. 7.—Syphons at Queen Street.

inches per hour with absorption varying between 30 per cent. and 50 per cent.

Design of the Relief Sewer.—At the point selected for relief of the existing Garrison Creek sewer it was found that a quantity equal to 945.76 cubic feet per second had to be taken by the relief sewer which, on its course to the south, receives additional discharges until at it outlet a capacity of 1,296.90 cubic feet per second is required.

Generally speaking, grades are good, and give high velocities—much above the orthodox sewer requirements. However, these sewers are idle most of the time, so that matters of wear and tear, due to high velocities, do not figure.

Starting at the lake (south end) at the 0+00 of Section No. 1, a head-wall is provided for the 10-ft. 8-in. by 10-ft. 8-in. arch and invert culvert. This headwall with the apron is not designed as a permanent structure in view of a probable future extension into the lake to the sea-wall limit. Fig. 4 gives the details of headwall and apron. Fig. 5 shows the type sections adopted in Section No. 1. The flat top section was necessary in order to pass under the railway tracks and to get a minimum 4 feet of cover from top of sewer to base of rail, as required by the Railway Board, order No. 13494.

With the exception of the portion across the railway tracks the culvert was designed for tunnel work, and is being executed in that manner.

At King Street the high level interceptor had to be crossed, and special invert castings provided in order to keep grade in both sewers.

The existing sewers and proposed relief sewers draining into Section 2 presented difficulties which have been overcome in the manner shown in Figs. 6 and 7.

Fig. 6 shows the type of culvert adopted in this section of the work. From station 11+54 to 23+73 it will be seen that a small sewer is "tucked in" the wall of the culvert. This sewer has a flow in the same direction as the culvert, but as at a smaller grade. The type shown is for tunnel execution, the complete arch section of the top exterior being the main feature. At Queen Street (see Fig. 7) two syphons had to be constructed to take the sanitary sewage across the line of storm sewer. The grade of the existing Queen Street sewer did not permit of a sufficient hydraulic head being given so that excessively large diameter syphons had to be designed so as to permit any undue loss of head. A small overflow chamber is shown relieving the Queen Street sewer at this point.

At Argyle Street and Shaw Street (the end of Section 2) a large weir chamber is provided, as shown in Fig. 8. This is the overflow chamber for a proposed intercepting combined sewer, the sanitary flow from which is taken in the small sewer in the wall of the culvert to Queen Street and discharged there into the existing sewer via the syphon (to the north) shown in Fig. 7.

Section 3 completes this sewer and comprises a culvert, as before, with an overflow chamber at the existing Garrison Creek sewer. This chamber is shown in Fig. 9. The outlet of the existing sewer is throttled by adjustable stop-logs, so as to prevent any excess of storm water passing down. The sanitary sewage is prevented by the weir from running into the storm overflow sewer. Provision is also made in this chamber for a future sewer, which will parallel the existing one from the north.

Contracts for the whole of this work have been let and work is in progress all along the line. Tunnelling is general throughout, although it is probable that the north end of Section 3 will be executed in open-cut on account of made ground which is revealed by the borings.

Alternative tenders were called for brickwork arch, concrete arch of same dimensions as brick, and reinforced concrete arch. In every case the concrete arch (without reinforcement) was adopted as lowest in cost.

The borings throughout gave indications of good hard clay. In Section 2 water was revealed in small quantities and shale is reached.

The total contract cost of the sewer, which is 6,909 feet long, is $318,000.

Provision of the sum of $125,000 has just been made for the paralleling of the existing Garrison Creek sewer from the north end of the work described here to Bloor Street, completing the necessary relief and connecting up the whole system of storm overflow sewers for this particular drainage area.

CANADA'S MINERALS.

The production of the more important metals and minerals is shown in the following tabulated statement in which the figures are given for the year.

	1912 Quantity.	1912 Value.	Increase or decrease in value.
Copper ....Lbs.	77,775,600	$12,709,311	+$ 5,822,313
Gold ....Ozs.	607,609	12,559,443	+ 2,778,366
Pig iron ....*Tons	1,014,587	14,550,999	+ 2,243,874
Lead ....Lbs.	35,763,476	1,597,554	+ 769,837
Nickel ....Lbs.	44,841,542	13,452,463	+ 3,222,840
Silver ....Ozs.	31,931,710	19,425,656	+ 2,070,384
Other metallic products	....	982,676	+ 571,344
Total..............		$75,578,102	+$17,478,958
Less pig iron credited to imported ores	987,232	14,100,113	+ 2,406,392
Total metallic		$61,177,989	+$15,072,566
Asbestos and asbestic ....Tons	131,260	2,979,384	+ 36,276
Coal ....Tons	14,699,953	36,349,299	+ 9,881,653
Gypsum ....Tons	576,498	1,320,883	+ 327,489
Natural gas	....	2,311,126	+ 393,448
Petroleum ....Brls.	243,336	345,050	— 12,023
Salt ....Tons	95,053	459,582	+ 16,578
Cement ....Brls.	7,120,787	9,083,216	+ 1,438,679
Clay products	....	9,343,321	+ 983,388
Lime ....Bush.	7,992,234	1,717,771	+ 200,172
Stone	....	4,675,851	+ 347,094
Miscellaneous non-metallic	....	3,364,017	+ 1,221,175
Total non-metallic..		$71,949,500	+$14,833,929
Grand total		$133,127,489	+$29,906,495

*Short tons throughout.

CONCRETE IN RAILROAD WORK.

The railways of Canada, in their yearly expansion in road buildings, have had, among other things, to add to each year's expenditures for concrete work. In a paper before the National Association of Cement Users, at Pittsburg, Mr. M. S. Long deals with the use of cement by the railways as follows:—

"Concrete in Railroad Work," is a subject so broad that it is difficult to tell where to begin. Concrete, to this generation, seems a new material, but history tells us that it is a very old one, having been used in the Roman baths and in concrete bridges still in use in Italy, which were built 1,500 years ago.

For many years the secret for making concrete was lost, but concrete is now used probably more than any other building material, and is considered, by some, as being infallible and a substitute for every other building material; but it must be given proper treatment or it will be sure to cause trouble. The railroads, which are, to my mind, the master builders, are using millions of barrels of cement every year, and each succeeding year sees them using concrete for a greater number of structures.

Concrete, properly used, is perhaps the most permanent building material we have in use to-day, but because it is such, and because the railroads are really in their infancy, there are some structures they hesitate to make too permanent. As stated before, we have examples of concrete structures 1,500 years old. Compared to that, the first railroad station in Chicago was built near the junction of the present Canal and Kinzie Streets, in the fall of 1848. That was only 64 years ago, and perhaps that building would be good enough for use to-day, had progress not caused it to be replaced many times by larger structures, better adapted to the handling of the increased business—even in 12 years the depth of our engine houses has increased from 75 feet to 95 feet, and now we are making plans for a house 115 feet deep. And so, in building our railroad structures of concrete, though we feel that they should last even longer than the 64 years referred to, who can say that they can be operated economically even 25 years hence. Therefore, were it not for the demands of progress, I believe that the majority of all buildings would be built of concrete; but the tearing down of concrete is difficult—therefore, expensive and wasteful, because the salvage cannot be re-used to advantage.

For foundation work, concrete plain or reinforced, is almost always used, because for that character of work it is cheaper, stronger, more flexible and can be built in a shorter time than with any other material.

We have used it for coaling stations, where 800 tons of coal is stored over main tracks, and for this character of building it is very satisfactory.

We have used it for water tanks, where a large storage is desired and high pressures are needed. We have built three tanks of 100,000 gallons capacity, and with one of them we had considerable trouble. This tank is 24 feet in diameter, 80 feet high, and not only furnishes water for the engines but is our supply for fire protection. From the base of rail to the water line in the storage compartment is 50 feet. This tank was finished late in December, and was filled to within 4 feet of the top a few days after it was completed, and on the day it was filled the temperature fell to zero. It so happened that orders were not issued for engines to take water at this tank until about two days after it was filled. We found that, in the meantime, a layer of ice had formed—it being about 18 inches thick around the sides but in the centre it was not more than 1 inch thick. The water was

used until the gauge showed the tank empty, and about this time the weather had moderated and the ice fell. In breaking loose, it tore the waterproofing off and this allowed the water to percolate through the walls and freeze on the outside—the ice collecting in chunks weighing a ton or more. When the weather moderated, this ice fell off and we found that the walls were damaged very little, and with an application of waterproofing on the inside and a coating applied to the exterior with a cement gun, the tank held water satisfactorily, and we have had no trouble with it since.

From the experience we gained, we would recommend that concrete structures of this character be coated inside and outside with waterproofing, and be allowed to cure before water is put in. Our trouble was caused, no doubt, by the concrete not being protected until it had thoroughly cured, and as there was still moisture in it when the zero temperature struck it, the water in the concrete froze, and when it thawed it left pores through which the water could escape.

The other two tanks are 53 feet high, and we have two reinforced concrete reservoirs, 55 feet in diameter, 12 feet high, built on the ground—the latter each hold 200,000 gallons and are giving satisfactory service. They are, each one, coated inside and out with waterproofing compound.

We have built reinforced concrete cinder pits, where hot cinders are dumped and then drenched with cold water. Here we find that concrete must be faced with vitrified brick, as alternate heat and cold cause it to spall. We have tried using slag as a substitute for stone in these pits, and find it an improvement, but it is not altogether satisfactory.

We have built pump houses, where the pumps are placed in a water-tight compartment below the water level on the outside.

Also, subways for passengers going from one platform to another. The one I have in mind being below the water level, so that it was necessary to waterproof against the water pressure. In this instance, we kept the water down by pumping and laid a cinder concrete base to receive the "Membrane" method of waterproofing. After the work was completed, the water developed a greater head than we had figured and some leaks developed. In repairing them we found that the cinder concrete, which was made from soft coal cinders, had not set up. We have since learned that others have had experience similar to ours, and upon testing it, we find that the soft coal cinders contain a great deal of sulphur. This is not true of hard coal cinders, and the latter are the only kind that should be used in concrete.

We have built one reinforced concrete engine house, as we are reasonably sure that this structure will be permanent, but we used a wood roof, as we felt that the escaping steam would condense on the cold concrete ceiling and drip off on the engine jackets.

We have built a reinforced concrete grain elevator for the storage of grain, and although the concrete was mixed rather wet, we had considerable trouble with dampness at times during hard, steady rains. We applied waterproofing to the outside of the walls and since that time have had no trouble from dampness.

We are now building an eight-story reinforced concrete warehouse in New York City, and do not expect to waterproof the exterior walls above the ground line in any way, for we believe that in a structure of this character that by careful mixing and careful placing and working the mass into place it can be made sufficiently waterproof of itself.

In conjunction with the Lake Shore & Michigan Southern Railway, we built a passenger station at Gary, Ind., which is practically all concrete. The building is Classic in design and the lines and shapes are the same as if cut stone was to be the material used.

During the past year we found that we could buy watch boxes and telephone booths, of reinforced concrete, cheaper than we could build them of wood, and we have now adopted the concrete ones as our standard.

In making plans for some small shop buildings, within the past year, we specified wood construction, also steel frame covered with metal lath, plastered both sides with cement mortar, making the concrete wall, approximately two inches thick, and were agreeably surprised to find that the bids for the steel frame and concrete were as cheap as the wood construction, and, of course, concrete was adopted.

In our track elevation work at Chicago, concrete is the principal material used, and the results obtained are very satisfactory, and the design and general appearance of that part of the work through the parks has been very favorably commented upon by the Park Board.

There are many reasons why concrete is chosen by the railroads in preference to other materials, some of them being as follows:—

1. Its rigidness, especially in buildings containing machinery.—Vibration in a properly constructed concrete building is negligable.

2. Its low cost of maintenance.—With a good concrete structure the maintenance should be very low, as the structural parts should last indefinitely.

3. Its fireproofness.—We consider our reinforced concrete structures so nearly fireproof that we carry little or no insurance on them. We do, of course, carry insurance on the contents.

4. Its waterproofness.—Reinforced concrete, when properly mixed, can be made practically waterproof against small pressures. It should be mixed wet and well worked into place to obtain this result.

5. And perhaps most important, is the cost.—Compared to a structural steel fireproof building, its cost is lower but it is more expensive than ordinary mill construction, and it is up to some of you to design a flexible form that will help cheapen the cost—a form that can be used over and over again and flexible enough to fit any wall or column.

There are a number of other things that you, who are making a life work of concrete in its various phases, should give consideration. It would be universally used as a wearing surface for freight house floors, passenger platforms, etc., were it not for the fact that its surface is so likely to become chipped and broken, and once broken it wears very fast. We are now making some tests with ironite worked into a rich mixture for wearing surface, and while this increases the wearing qualities, it is not as satisfactory as we would like. We also find that concrete floor surfaces dust badly, and it is necessary to resort to the use of linseed oil and shellac, or to hot silicate of soda, which eliminates the dust for a time.

Another adverse feature of concrete is contraction cracks. As concrete cures it has a tendency to crack, and this gives it the appearance of having veins, especially so where moisture has had a chance to enter through these small cracks. Where the mass of concrete is waterproofed this is a serious proposition, and we would like very much to have this problem solved, as I am sure many more buildings would be constructed with a concrete wearing surface, were it not for the fact that these incipient cracks ruin the appearance of the structure. A great deal of this is, no doubt, caused by finishing the surface with a very rich mixture—should it be necessary to patch voids in the surface we specify that the mixture should be no richer than the mass. We specify our concrete surfaces to be finished by rubbing with a concrete brick. We also find that where cracks occur the moisture entering the mass starts a chemical action which results in the surface being ruined by efflorescence.

Another step forward in the use of concrete would be to make it in colors. This does not mean by painting, but the coloring matter should be mixed, or probably ground, with the cement, and great care must be taken to get each batch properly proportioned. This is only a suggestion, as chemical action may make this a hard problem to solve.

I have tried coloring on two different structures. This coloring was brought about by the use of sand. On one structure we used a sand that had a reddish-brown tinge—this gave a rich, warm buff color. On another structure we used a sand similar, except that it was lighter, and this gave a color a little darker than cream. Am quite sure that concrete will have many more friends, especially in residence work, when you can produce it in colors that are warmer than its natural one.

Concrete is so lasting that you must be doubly sure to get a pleasing design and, in my opinion, your success lies in handling it in large surfaces. Don't try for too much detail, such as you see in some structures built of cement blocks.

These remarks are based on practical experience, and I trust that they will help to stimulate the discussion of the many interesting features of this broad subject.

ROAD CONSTRUCTION.

Ontario, more so than any of the provinces, has spent money and endeavored to make its road system modern and equal to present day traffic requirements. W. A. McLean, Provincial Engineer of Highways, in carrying out of the plans of the province, has had opportunities of studying and knowing the requirements of roads in a way that makes his report to the government particularly interesting. Writing, as regards road construction, he states:

A perfect roadmaking material, or a single type of road, possessing every desirable quality for service, durability, and cost, has not been found, and from natural reasons, cannot be expected to exist. Roads must be adapted to the traffic they are to carry, and since traffic differs greatly in character, road construction must be varied accordingly. The problem in general is, to use local materials to the best advantage.

Motor traffic is leading to important requirements and modifications, but gravel roads, and broken stone roads substantially as advocated by Tresaguet in France, and Telford and Macadam in England, continue to be the mainstay of road-building.

All roads are important and each deserves a type of construction and system of maintenance in keeping the traffic over it. Some roads have only an occasional vehicle passing over them; others may have an average of 1,500 vehicles of all descriptions. Some carry light single-horse vehicles principally; others have a greater proportion of heavy teaming. The amount of motor traffic varies from roads which have few automobiles to those which have a large number of motors and few horse-drawn vehicles. A gravel road will give good service to a considerable amount of light driving; and an oiled gravel road will serve a very large motor traffic if there is a small proportion of horse-drawn vehicles. A water-bound macadam road is easily maintained under a considerable amount of heavy teaming and light driving, but if even a small proportion of rapid motor traffic is added, the cost of maintenance is much increased; and if motor traffic is of large amount, an asphalt or tar binder becomes necessary, or a durable pavement should be considered. Painting with tar or asphalt will give good service where motor traffic is heavy, with few horse-drawn vehicles; but if proportions of travel are reversed a bituminous paint coat is much less effective. These examples suggest some of the factors entering into the design of a road.

Road Classification.—The roads of Ontario may, for a consideration of construction, be broadly divided into three classes; one grade merging into another, however, at the arbitrary dividing line. It is estimated that in the organized counties of old Ontario there are 50,000 miles of road, and a classification would be approximately as follows:

1. Trunk roads connecting the large towns and cities	5%	or	2,500 miles
2. County or leading market roads	12%	or	6,000 miles
3. (a) Main township roads	50%	or	25,000 miles
(b) Secondary township roads	33%	or	16,500 miles
Total	100%	or	50,000 miles

In the foregoing classification, the roads described as "Trunk Roads" are, with the exception of a few connecting links, among the most important of the county roads, and are heavily travelled for local market purposes, but they carry as well an increasing amount of through inter-urban traffic. The heavy and complex nature of this traffic requires, as a rule, construction of the most durable type varying from a concrete, brick, or other durable pavement to first-class macadam. The classes one and two, including trunk roads and leading market roads, thus include two divisions of what would be the main county roads of the Province. These comprise 17 per cent. or 8,500 miles in all, which if properly selected and constructed should carry 80 per cent. of the traffic of the Province.

The main township roads comprise principally the concession roads on which numerous farms front and which converge into and create the traffic of trunk or county roads. The more important of these should be metalled with gravel or broken stone, if available. Secondary township roads include the little travelled connecting roads which should be graded and given such further treatment as circumstances may permit. The first need for the roads classified as township roads is thorough grading, draining and bridging, and systematic maintenance with the log drag.

Gradients adopted, amount of camber or crown, width and depth of metal, foundation if any, drainage, binding material, and other details, should, as suggested, be largely dictated by the degree of traffic. A good road attracts and creates traffic so that the construction of any one road is very likely to raise it from one class to a higher grade, a matter which should not be lost sight of in planning improvement. Methods of construction should be as simple and direct as proper results will permit. There should, for true economy, be a well adjusted average between maximum service and minimum cost.

Trunk Roads.—Broken stone roads of the best class have been reduced to a few well-defined types, through more than a century of experience in England, France, Germany, and on this continent. The true macadam road has a well-defined and crowned earth sub-grade, over which is spread a uniform coating of finely broken stone of about 2½ inches diameter. The Telford road has a foundation of flat quarry stones, placed by hand, on edge, the angular points being chipped off by hammer and wedged into the interstices; and over all is spread a coating of finely broken stone, in thickness about one-third of the total depth of the stone surface. The earth sub-grade is flat and larger stones are used at the centre of the road, with smaller at the sides, to give the desired camber. The roads built by Tresaguet in France, were substantially the same as the Telford road and are usually included with it. In the former, the sub-grade was cambered, and the foundation stones of uniform depth. A

distinct type of foundation is that developed in Massachusetts in which there is a slightly V-shaped sub-grade with a filling of cobble or field stone, a method which is claimed to give more effectively than other types, a desirable under-drainage.

Experience has shown the superiority of roads with a foundation, such as the Telford type, in reducing the cost of maintenance under heavy traffic. Settlement is more uniform, and defective drainage is less destructive. If the natural sub-soil is strongly supporting, such as a dry, well-cemented gravel, the foundation may be omitted with saving of cost. Whether the Telford or Massachusetts type of foundation be allowed, the local material suitable for either should largely govern.

The width of roadway between gutters or drains, and the width of stone should be guided by the amount and character of traffic, and should ordinarily be less in strictly rural districts, increasing as roads converge into city streets. A minimum width of grade for trunk roads should be 24 feet with metal in the central 12 feet, and earth or gravel shoulders six feet wide on each side. Maintaining shoulders at six feet, and a maximum width of metal at eighteen feet, the maximum width of grade need not exceed thirty feet.

The camber on roads of heavy travel should be the least possible, consistent with good surface drainage, factors to be considered being the quality of road metal, class of binder, and gradient of the road. As is well known, roads with a sharp crown encourage travel in one central line of wheel-tracks, while a flatter surface permits more uniform wear.

A hard rock such as trap, or a bituminous binder, requires less camber than soft material and an inferior binder, while a steep grade requires an increased camber to drain the wheel tracks. Trunk roads of the best class may be given an average crown of one-third or one-half an inch per foot from centre to gutter.

County or Main Market Roads.—Roads of this class cannot as a rule follow closely English, French, German, or other standard, but must be built with a view to the particular needs of this continent, and of the locality. The immediate need is a long mileage, to be built as rapidly as possible, through districts where population is comparatively sparse, often where there may be little or no road-making material, and the available expenditure necessarily restricted by these and other conditions.

European engineers would, undoubtedly, if it were possible to reconstruct many of their roads, lay them with foundations, but the cost is prohibitive. No more is it practicable on this continent to build any but the most heavily travelled roads with expensive foundation. Instead, it is necessary to depend on good drainage, carefully maintained to keep the sub-soil dry and strong enough to sustain the road surface.

Road-beds should have sufficient drainage for the severest test, which in northern countries is that period of thaw in the early spring, lasting usually for two or three weeks; just as bridges have to be strong enough for the maximum load, and with waterway enough for the maximum freshet. If sub-soil drainage is sufficient for the test of spring, no break-up of the road crust need be feared at other seasons.

Old specifications for roads built before the period of railway construction in Ontario, required open drains on each side of the road, with bottom at least two feet below the crown of the road. In most cases the drain was deeper; and hills or spouty places were under-drained with trenches filled with field stone. Such roads have stood the test of time, and may be accepted as the standard of drainage required for the north; except that tile under-drains are taking the place of open ditches where they would otherwise be dangerous, unsightly or difficult to maintain. Drains of porous farm tile keep the sub-soil at its driest and prevent uneven settlement of the road crust into mud which is as destructive to a road when below the surface as when on the surface. Some counties of Ontario are using tile drains the full length of all their roads. Others use them only on wet and spouty hills; on level land which is exceptionally wet and retentive; and where the open drain would otherwise have to be dangerously deep to give sufficient fall and outlet. In the last case, the tile may carry some surface drainage, receiving it in catch-basins.

Closely associated with drainage is the grading of the road. Before a road is surfaced it should be brought to grades that ensure permanence. Hills should be cut down, low places filled, and the earth work brought to a substantial turnpike. The road surface will need renewal, but the grade, if properly made, will outlast even the bond issue. On roads of a secondary class elaborate surveys are unnecessary. A good foreman can obtain easy flowing gradients by grading from point-to-point, and would probably disregard stakes and profiles except in cases of extensive cuts and fills, new locations, tile drains, or doubtful surface drainage, which should always be staked by an engineer.

Roads laid on an earth foundation should be given a higher crown when newly constructed, than is desirable for perfect condition. Settlement will assuredly occur, and unless the road is too high to begin with it will become too flat. A road of a secondary class which in two or three years has settled to the desirable camber will give the greatest degree of durability, with least expense for maintenance. One inch to the foot from centre to gutter or edge of shoulder, for a completed, rolled road, will meet ordinary conditions; with a circular cross-section, the greatest part of the fall is on the earth shoulders.

The cost of a road, unless earthwork and drainage is of an exceptional kind, will depend on the width and depth of broken stone used. Wide flat roads are desirable, but narrow roads with a good camber cost less to build, and much less to maintain, unless a highly organized system of maintenance is created. For this class of road and earth grade twenty-four feet wide, shoulder to shoulder, will meet most conditions; but may be reduced to eighteen or twenty feet for least traffic. With shoulders six feet wide, the stone is put on from eight to twelve feet wide.

The consolidated depth of metal on roads is based on 8 inches for a moderately strong clay or sand sub-soil. This is modified according to the anticipated amount of traffic and quality of stone to resist wear; the maximum concentrated wheel loads; local tire widths and wheel diameters; bond of road metal and consequent distributing effect of the stone crust; the supporting strength of the sub-grade and opportunity for drainage.

Bituminous binders may be justified on heavily travelled suburban or motor roads of this class, but present practice in Canada tends to oiling as a preservative and dust preventive, owing to the less first cost of water bound macadam.

Township Roads.—Reduction of cost to meet township conditions requires that townships have as their ideal, the cheaper class of roads adaptable for main county roads. Grading is cheap, and should be perfected before metal is applied. Neglect to provide easy flowing gradients, and to sufficiently drain and turnpike are mistakes fatal to any road. Minor municipalities can make no mistake in creating the perfect earth road as their ideal base for such metal surfacing as their resources will permit. An earth-grade from eighteen to twenty-four feet shoulder to shoulder should be made, and a single track laid eight feet wide, of gravel or broken stone.

Binder.—The durability of a road is largely dependent on the binder, and the cementing qualities of the stone dust, in producing a waterproof surface,—if tar, asphalt, rocmac or other special binder is not used. Stone screenings are more preferable than sand. Very rarely can gravel or sand, sufficiently clean, coarse and sharp, be found to make a binder equal to limestone screenings. The superior cementing qualities of limestone, make it a better road metal than its degree of toughness would justify. Limestone screenings are also exceedingly useful with water washed gravel, or with broken granite or trap, all of which are deficient in good bonding qualities.

Coursing Stone.—A uniform grade of stone, rather fine, is desirable in finishing the surface of a road, and is necessary where a very hard stone such as trap is employed; but this may be sought at considerably increased cost, and is not always necessary to suitable results. It adds to the cost of a road to spread the stone in several layers. Municipalities using portable crushers particularly, will find a rotary screen with two sizes of mesh very satisfactory. This will produce, (1) "Tailings," or the stone too large to pass through the screen; (2) the middle course, a uniform grade to form the main body of the road; and (3) screenings to bond and finish the surface. The tailings should be spread in the bottom of the road, and covered to the required depth with the uniform grade; and this, after rolling, may be lightly coated with screenings and rolled. If a very tough stone such as trap, the screenings may be such as will pass a one-half inch mesh, or a one inch mesh if limestone; and the uniform grade of stone may be two inches for trap, and two and one-half or three inches for limestone, with the screenings removed. Crushing and handling are cheapened by the system, and for water-bound roads, a smooth surface results.

Trap or other tough rock brought from a distance by rail in preference to the use of soft local material, is justifiable for surfacing heavily travelled main roads; but it is a safe rule, if applied with discretion, that local material if it exists, should be used.

Gravel Roads.—Gravel in general is inferior to broken stone as a road material, but if of a reasonable quality, is suitable for township roads, and for many county roads but, unless of exceptional quality, is deficient for extremely heavy traffic. The rounded pebbles do not take the mechanical clasp that pertains to fragments of broken stone, while the sand which it usually contains is not equal to stone screenings as a binder. It may contain lime or iron, improving its bonding qualities, but as a rule it is not water-proof, and ruts readily in wet weather, especially if it contains sand, clay or loam in excess.

The best quality of gravel is of varying sized grain up to 2 inches in greatest dimension, with only sufficient fine material to fill the voids between pebbles. It should be clean and made up largely of a uniform grade of pebbles—qualities rarely found in natural pit gravel. Gravel pits containing a mass of large stones and boulders should be treated as rock, and put through a crusher. Gravel which is not coarse, but which is "dirty" or contains fine sand, should be screened to remove the excess of sand or clay. A rotary screen may be used, operated by steam power. The gravel can be drawn in wagons to an elevated platform, dumped into a hopper from which it passes through the rotary screen, and from the screen to an elevated bin, from which the screened gravel is again loaded into wagons to be taken to the road. By means of the elevated bins the expense of shovelling into wagons is saved, the time of teams and teamsters is saved, and a well arranged plant will, under favorable circumstances, pay for crushing and screening. This is particularly the case if a pit near the work can be used rather than to team better material a long distance.

Methods.—The methods of construction will largely determine the cost. Machine work is cheaper than manual labor. The cross section adopted should, therefore, permit the maximum amount of machine construction. Particularly for the cheaper class of roads, the grading machine, in treating with old locations, should do most of the earthwork, supplemented with wheeled and drag scrapers. A cheap and good plan is to make the earth sub-grade, shoulder to shoulder between ditches, almost flat, or with a central rise of about three inches for a 24 foot grade. When this is rolled, the stone is spread to the desired width in the centre, then with the grading machine, earth is drawn from the shoulders to support the stone, thus completing the camber. The stone is first rolled dry to level and partly compact the surface, the screenings are then spread, sprinkled and rolled till consolidated. To grade the road and then excavate a central channel to receive the metal is a more expensive method, and is apt, for roads without a foundation, to place the stone too low for good drainage, producing what may be termed a "water-logged" road. Instead of the camber and turnpike being high enough to allow for settlement, it is apt to be made too low and flat.

Rolling.—As distinguished from earlier road-making, modern construction has been largely influenced by machinery, especially grading machines, rock crushers, and road rollers. The smaller municipalities of Canada commonly use graders and crushers, but the purchase of a steam roller is too often delayed. It is to be pointed out that the cost of a roller is by no means an additional expense, since rolling effects economy in several ways. Coarser stone can be used in a road that is rolled, so that the cost of crushing is reduced. With coarser stone, the road is stronger to resist wear, and is more securely bonded than if first rutted and mixed with mud. Less stone is required in a rolled road, as loose stone is largely forced down into the mud before the surface becomes waterproof, or is knocked to the ditches by traffic. Without rolling, roads demand attention for one or two years, to rake the stone to place from time to time; the earth shoulders have to be restored and levelled where cut up and destroyed by traffic, new material has to be added to fill hollows and ruts. By rolling the sub-grade, the wet or weak spots are developed, which can be drained or filled with earth and again rolled to produce a uniform foundation; thereby reducing the stone which the road would otherwise absorb. Long lines of loose stone left for traffic to consolidate are a most objectionable obstruction to travel, and bring road-building into disrepute. On the other hand, a road built with a heavy roller is a complete work, in perfect condition when finished. Rolled roads are a revelation to those who have been accustomed to and who expect only old-time methods and results. For both economy, service, and to popularize the work, rolling should be regarded as essential for every class of gravel and stone roads.

The process of melting abstracts or renders latent a definite quantity of heat, and it is the loss of this heat in the melting of ice that gives it its refrigerating value. This heat, which is used up in the melting of ice, is the latent heat of fusion of ice, and it amounts to 142 heat units per pound of ice. When one pound of ice changes to water the heat that is abstracted is equivalent to what would be required to raise one pound of water 142 degrees Fahrenheit, or required to raise 142 pounds of water one degree Fahrenheit. This quantity of heat is considerable, and accounts for ice being a better cooling agent than ordinary cold water, or even water at 32 degrees Fahrenheit. One pound of ice in melting has, therefore, 142 times the cooling value of one pound of water in passing from 32 degrees to 33 degrees Fahrenheit.

PROPOSED SOUTH SASKATCHEWAN RIVER DIVERSION CANAL.

In the issue of *The Canadian Engineer* of March 6th, 1913, there was an article on the Moose Jaw water supply, by Mr. Gillespie, associate professor of Applied Mechanics, University of Toronto. In this article Mr. Gillespie mentioned that the ultimate source of the water supply at Moose Jaw, if the city increased its population, must be the Saskatchewan River. We publish below a report by the Commissioner of Irrigation, F. M. Peters, on the proposed South Saskatchewan River Diversion Canal. This scheme, if carried through, will be the probable source of water supply for both the city of Regina and Moose Jaw. The estimates of costs given will be of interest to engineers and contractors.

The height of land of Aiktow Creek in township 24:—

High-water level in river	1,632 feet
Height of land, head of Qu'Appelle River	1,720
Difference of elevation	88

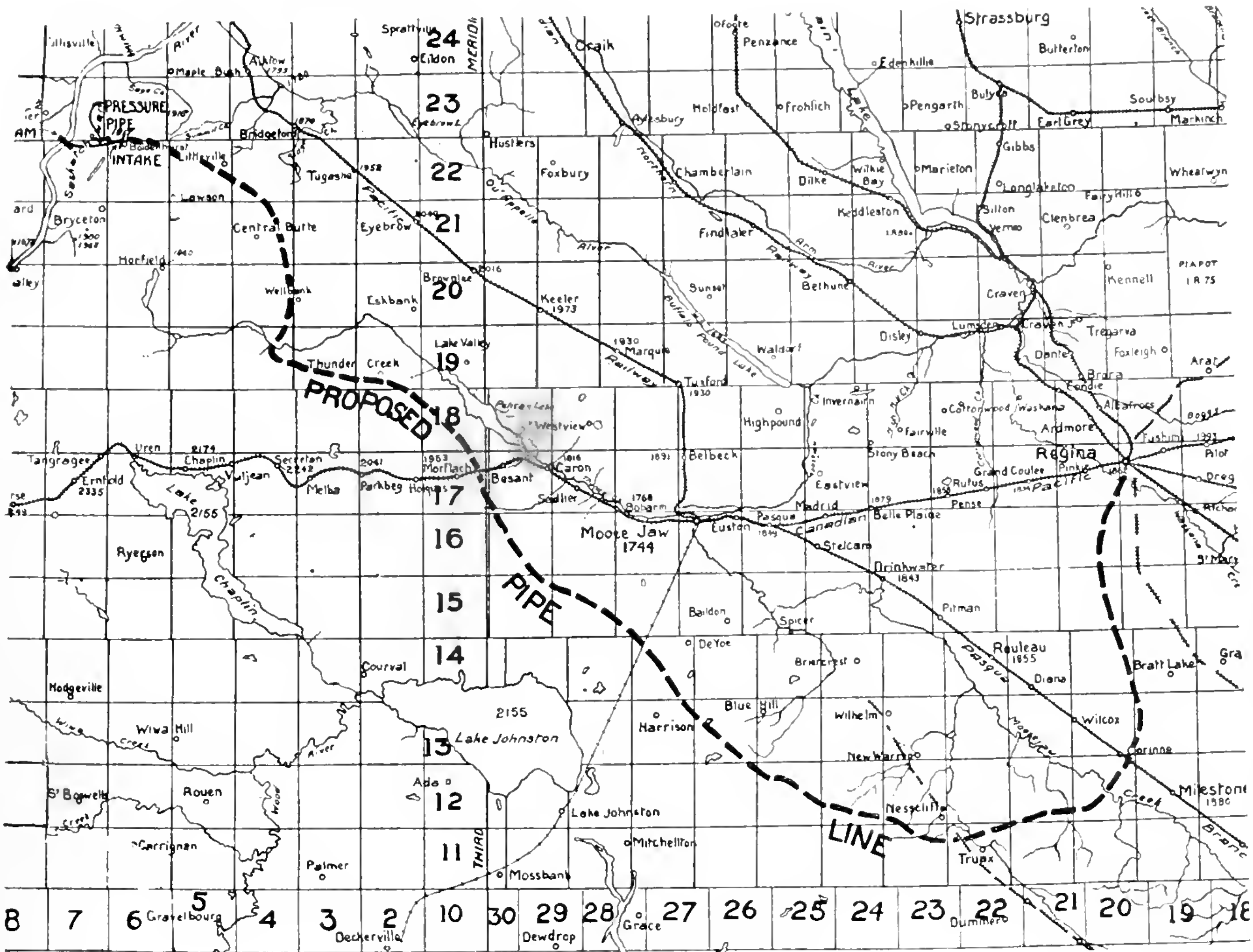
The height of land of Sage Creek in township 23:—

High-water level in river	1,644 feet
Height of land, head of Summit Creek	1,916
Difference of elevation	272

The height of land of Shellstone Creek in township 21:—

High-water level in river	1,672 feet
Height of land, head of Thunder Creek	1,975
Difference of elevation	303

All the elevations given above are to the datum of the Canadian Pacific Railway levels.



Map of Proposed Diversion Canal.

Scale 1″ = 16 miles

A proposition in connection with this scheme, which has been looked upon with some favor is the proposition to pump water out of the South Saskatchewan River over the height of land and deliver it into the head-waters of the Qu'Appelle River. The work was confined entirely to developing the critical elevation along these lines and consisted of running a series of level lines over several heights of land which showed possibilities of feasibility. Mr. Russell was at this work for one month and had the assistance of only one rod man and a team and driver.

The results of all Mr. Russell's work is plainly set forth on the plans and profiles submitted in connection with this report, but for purposes of convenient reference the results may be set forth as follows:—

It should be noted that the pumping of water over the height of land of Shellstone Creek would allow the water to run by gravity down to the city of Moose Jaw and from there down into the Qu'Appelle River.

The project of pumping the water over the Aiktow Creek height of land and allowing it to flow down the Qu'Appelle River would probably be useless, as it would deliver the water into Buffalo Pond Lake at an elevation of 1,627 feet, which is about 117 feet below the elevation of the city of Moose Jaw. Then, allowing a grade in the Qu'Appelle River of two feet per mile, as the crow flies, the elevation of the water in the Qu'Appelle River at a point southeast of Regina (about twenty miles from Buffalo Pond Lake) would be about 1,587 feet or 275 feet below the elevation of the city of Re-

gina. The bed of the Qu'Appelle River is, moreover, of such a character, viz., black swamp earth, that any water turned into it for domestic purposes would be badly polluted.

Mr. Russell also developed a cross-section of the South Saskatchewan River at a point about midway between the mouths of Aiktow and Sage Creeks for the purpose of making a preliminary study of the cost of a dam. This section will give probably as small a cross-sectional area for a dam as any section that can be found on the river in this vicinity. It was also ascertained that the fall of the river water-service in townships 21 to 24, a distance of 31 miles, is 40 feet, or an average fall of 1.3 feet per mile.

Study of Pumping and High Level Gravity Scheme.—Before proceeding with this short study it may be stated that this scheme is a very large one and will be very expensive. It is, therefore, impossible for any person to give an advised judgment on the matter until the topographical features of the country have been fully developed, and the feasibility of dam construction in the South Saskatchewan River fully probed. This study is, therefore, made without any of the requisite information being available, and it must be accepted only as a rough, preliminary study made in an attempt to point out what appears to be the most feasible scheme, together with a rough approximation of the cost.

The purpose to be attained by this scheme is to serve that dry country in what may be termed the Moose Jaw and Regina districts, and the basis of the study is the requirement to deliver a gravity supply as far east as Regina and at the elevation of the rails of the Canadian Pacific Railway in that city. The quantity of water to be diverted has been taken as stated in the application made by the government of the province of Saskatchewan, which is about 200 cubic feet per second.

It is submitted, as a matter of opinion only, that the only feasible scheme is to place a dam in the South Saskatchewan River and develop there enough water-power to pump the required quantity of water to a sufficient height on the side-hill of the river from whence it can be run by gravity to meet the requirements of the situation, which is to deliver a gravity supply at the elevation of the Canadian Pacific Railway at Regina. The supply must be delivered during both summer and winter for domestic purposes, and, with this end in view, the available water-power in the river has been based on the figures of minimum winter-flow.

The cost of a gravity line has been estimated by assuming that the water would be carried in a circular reinforced concrete pipe. It has been assumed that the demand for water will be equal from the intake to the delivery at Regina, where a flow of 50 cubic feet per second has been allowed, and the total length of 170 miles of pipe line has, therefore, been divided into four sections having, from the intake on, carrying capacities, respectively, of 200, 150, 100 and 50 cubic feet per second. The excavation cost has been based on a level section cut for the trench sufficient to bury and cover the pipe everywhere with six feet of earth. In computing the cost of the dam the section used is that one taken in township 24 between Aiktow and Sage Creeks, but, in order to suit the assumed scheme, the dam must be placed somewhere in townships 22 or 23. One fact alone which is liable to make the estimate of the cost of the dam seriously in error is that the bottom of the South Saskatchewan River is known to be most treacherous for the foundations of any structure, and no definite information whatsoever has been gained on this point.

The small-scale map accompanying this report shows the position of the dam and the location of the proposed pipe line, while the calculations following hereafter have been made in such a way that they may be read through understandingly by any person who has followed this preliminary discussion. The unit prices assumed in the estimate are understood to include the cost of many small details and incidentals which have not been calculated. For example, it will not be possible to obtain the minimum excavation section for the pipe line throughout, which will make the quantity of excavation much higher than that calculated.

In conclusion attention may again be drawn to the fact that this study is only a rough approximation and that nothing further can be attempted until the many controlling elements of the scheme have been fully developed by the carrying out of the proper surveys and also river borings to develop the possibilities of a dam foundation.

DETAILED DISCUSSION.

To find the height of dam necessary.

Argument.

H_R = head required for turbines in river to pump Q_C into pipe

Q_R = available L. W. flow in river assumed = 3,000 c.f.s.

C_1 = efficiency of turbines and direct connected centrifugal pumps assumed = 52%.

C_2 = loss due to friction in pipes from pump to delivery assumed = 10%.

H_C = height of lift to pipe.

Q_C = quantity required in pipe assumed = 200 c.f.s.

Formula $H_R \times Q_R \times C_1 \times (1\text{-}C)_2 = H_C \times Q_C$

Study.

Regina elevation	1,862 feet.
Length of canal	170 miles.
Grade of canal = 1 in 10,000 or 0.528 ft. per mile.	
Head required for canal = intake to Regina..	89 feet.
Intake of canal (Boldenhurst Street) elevation	1,951 "
L. W. natural at dam (about)	1,653 "
Head required at dam (H_R)	37 "
Top of dam	1,690 "
Lift required—top of dam to canal intake	261 "

To find the cost of the dam.—The dam section developed on the river gives a cross-sectional area from the river-bottom to the crest of the dam, 37 feet above the lower pool, of 118,000 square feet. A preliminary study of the cost of the dam was made by Mr. W. G. Bligh, M.I.C.E., based on a concrete dam of the arched buttress type. The dam-section used was a very economical one, but of a somewhat bold design, and a rough estimate based on it gave a cost of $600,000. Owing to the uncertainty of the foundations and the many contingencies that might arise it would not be safe to estimate the cost of the dam at any less than $1,000,000.

To find the cost of turbines and pumps.

Theoretic H.P. required = .001892 Q.H. = 12,600.

Allow cost at $15 per H.P. = $189,000.

To find the cost of pressure pipes from pumps at dam to intake of concrete pipe line.

Q = 200 cu. ft. per second.

V = 3 s.f.

A = 67 sq. ft.

R = 4.6 feet (one large pipe).

Area plates required, including laps, 29 sq. ft. per ft. run.

Half-inch wrt. iron plates, weight per foot run, 580 lbs.

Cost, at 6 cts. per lb., about $35 per foot run.

Cost for 1 mile, $184,800.

To find the cost of concrete pipe.

Argument.

1.30 bbl. cement at $3.00	$ 3.90
0.44 cu. yd. sand at $1.25	0.55
1 cu. yd. stone at $1.50	1.50
Total cost ingredients 1 cu. yd. concrete	$ 5.95
Cement and stone	$ 5.95
55 lbs. steel at 3 cents	1.65
Forms, labor, and materials	1.85
Mixing and placing concrete, labor	0.85
Placing steel at 0.2 cents	0.11
Bending steel at 0.06 cents	0.03
Moving forms	0.30
Cost in place, 1 cu. yd. concrete	$10.74
Superintendence, plans, contingencies, etc.	1.26
Total cost in place, 1 cu. yd. concrete	12.00

To find the cost of excavation.

Argument.

Excavation, cu. yd.	$0.30
Back fill, cu. yd.	0.10
Cost per cu. yd.	$0.40
Superintendence, plans, contingencies, etc.	0.05
Total cost, 1 cu. yd. excavation	$0.45

To find cost of pipe line.—The grade throughout has been figured at 1 in 10,000 and the discharge of the pipe has been calculated by the Chezy-Kutter formula, using 'N' = .012.

Study.

Section No. 1, length 42 miles, capacity 200 c.f.s.

243,714 cu. yds. concrete at $12.00 .... $ 2,924,568
Cost per mile, $69,632.
1,576,935 cu. yds. excavation at 45 cents........ 709,621
Cost per mile, $18,834.

Total cost .... $ 3,715,586

Total cost per mile, $88,466.

Section No. 2, length 42 miles, capacity 150 c.f.s.

222,192 cu. yds. concrete at $12 .... $ 2,666,304
Cost per mile, $63,481.
1,576,935 cu. yds. excavation at 45 cents 709,621
Cost per mile, $16,895.75.

Total cost .... $ 3,375,925

Total cost per mile, $80,379

Section No. 3, length 43 miles, capacity 100 c.f.s.

152,633 cu. yds. concrete at 12 .... $ 1,831,596
Cost per mile, $42,595.
1,354,915 cu. yds. excavation at 45 cents 609,712

Cost per mile, $14,179.34.

Total cost .... $ 2,441,308

Total cost per mile, $56,774.34.

Section No. 4, length 43 miles, capacity 50 c.f.s.

127,912 cu. yds. concrete at $12 .... $ 1,534,944
Cost per mile, $35,696.37.
1,164,715 cu. yds. excavation at 45 cents 524,122
Cost per mile, $12,206.70.

Total cost .... $ 2,059,066

Total cost per mile, $47,885.25.

Total cost of pipe line laid, 170 miles $11,591,885

Summary of estimate of cost.

Cost of dam	$ 1,000,000
Cost of turbines and pumps	189,000
Cost of pressure pipes	184,800
Cost of concrete pipe line	11,591,885
	$12,965,685
Total cost, about	$13,000,000

FIRING OF STACKED COAL.

Every now and then some firm which has a quantity of coal on hand finds itself bothered from its coal pile having caught on fire. The question has been discussed lately in a paper read before the Manchester District Institution of Gas Engineers. Mr. Kendrick, who owns gas works of his own, relating his experience with them, stated that at Stretford they have had three serious fires in four years, and many cases of overheating. No. 1 store of coal held 1,800 tons, and was an old retort house partly roofed, with and partly without louvres. No. 2 store holds 1,400 tons and has no louvre. No. 3 holds 800 tons, and has a two-span roof of corrugated iron. In the first two, coal is delivered by conveyors. In No. 3 it is hand-stacked, 14 ft. high. In the other stores it is piled in pyramids 24 and 20 ft. high, the top of the cones being 8 ft. across. No. 1 shed had given most trouble. The finest slack is usually sent direct to the retorts, but much fine stuff still gets into the store and fills the middle part of the piles, and to this dust and small coal the fire trouble is due.

As a result of what was observed, after each boat had been discharged, the fine dust was dug out and spread over the heap, and pipes were put in at intervals to enable the interior of the pile to be watched. Three years of immunity led to laxity, and the small stuff had not been fully dug out, and a fourth fire occurred. It was again the small coal which heated, but was not the immediate cause. Some old screened coal was buried under the new coal, and the store was filled, in about six weeks, to its utmost capacity. On emptying the shed, the rough coal under the slack was quite carbonized and fire was creeping under the slack. Apparently air had reached the new coal through the old tongue of open rough coal. The temperature in the tubes rose slowly to 90 deg., then quickly to 110 deg., with a quick jump to 300 deg., and it required a week to reach the fire, which had then spread considerably. As this coal was stored in the hot month of May, 1912, and was stacked quickly and was dustier than usual, these causes appear to have been active in producing fires.

The colliery agents attribute the numerous fires of that year to the fact that after the strike, coal was much crushed at the face, and was very small, and it was not clean, being hurried away quickly for use, and more probably fresher coal than usual was stacked. Freshly-wrought coal is more prone to heat, especially if fine.

Coal as received is warmer than the atmosphere, as much as 2 deg. to 12 deg. in summer, and 4 deg. to 20 deg. in winter. Since a pit may have a temperature of 90 deg., coal must start from the pit fairly warm, and if stacked too soon, too high, or in too large mass, it is prone to heat. Also, coal mined first after the strike would be damper than usual, and dampness seems to engender fire.

Coals absorb from one to three times their volume of oxygen, and this produces heat, and if it can occur in a thick mass the heat accumulates. Stacking in cone shape from a conveyor causes the fines to accumulate at the apex, and

these are apt to fire. This system of storage is thus to be regarded with suspicion. Coal owners suggest 11 to 15 ft. as the height of coal stacks, or a mean of 13 ft. Gas works practice is to stack 10 to 30 ft. Since coal under cover cools less slowly, it should be stored in less depths than when out of doors, whereas the reverse is the usual practice. The question of ventilation is a disputed one. Some men say ventilate freely and carry off the heat. Others say keep out all hot air and no heat can be generated. If this is so it would be quite safe to store in closed bunkers, exhausting the air at the top and admitting CO_2 at the base to fill the voids between the coal. In practice it appears that coal will be reached by air enough to make it become hot. Therefore, supply ample air to carry off the heat, for the oxidation will be less if the coal is cold. Yet in mines ample ventilation to remove gas has caused heating in the gob, and the checking of the air current has stopped the heating.

If a heap fires, very much water is needed to quench it, for water sets up air currents to fan the fires. At Stretford they treat affected coal with strong ammoniacal liquor and only put water on unaffected coal. The summing up is that coal from different seams should not be mixed, nor should coal of different classes.

Fine slacks should not be stacked at all, nor damp coal under cover. Large heaps are the more dangerous. Lumps, nuts and fines should be well mixed in stacking. Limit heights to 20 ft. in the open, and 16 ft. under cover. Avoid external sources of heat, leaking roofs, &c. Keep temperature records of coal as received and in stock, and if the heat rises to 90 deg. or 100 deg., remove the top layers and watch carefully. Do not disturb a fired heap by pushing in bars. Do not apply water to a fire, but ammoniacal liquor. Remove and use heated coal promptly.

From remarks made during the discussion, it would seem that if coal is screened and stacked it does not become hot. This indicates the smalls as the cause of trouble. But it also indicates the need for good air circulation, for it is the fines that prevent this. It seems impracticable, as a rule, to gain safety by excluding all air, as that would undoubtedly prevent fire, for to produce fire there must be oxygen. The question is, can coal absorb oxygen, as oxygen which shall only begin to work when the coal is stacked? With present-day large stacks of coal, the subject becomes important.

MINERAL PRODUCTION BY PROVINCES.

The subdivision of the mineral production in 1911 and 1912 by provinces for Canada was approximately as follows:

Province.	1911. Value of Production.	1911. Per cent. of Total.	1912. Value of Production.	1912. Per cent. of Total.
Nova Scotia	$15,409,397	14.93	$18,843,324	14.15
New Brunswick	612,830	0.59	806,584	0.61
Quebec	9,304,717	9.01	11,675,682	8.77
Ontario	42,796,162	41.46	51,023,134	38.33
Manitoba	1,791,772	1.74	2,314,922	1.74
Saskatchewan	636,706	0.62	909,934	0.68
Alberta	6,662,673	6.46	12,110,960	9.10
British Columbia	21,299,305	20.63	29,555,323	22.20
North West Territories.	4,707,432	4.56	5,887,626	4.42
Dominion	103,220,994	100.00	133,127,489	100.00

CONSTANCY OF VOLUME ACCELERATED TESTS IN PORTLAND CEMENT.

At the meeting of the International Association for Testing Materials, amongst the discussions that arose the questions regarding constancy of volume accelerated tests in Portland cement were eagerly discussed. Professor Max Gary, in a paper discussing accelerated tests in Germany, states the accelerated test for volume constancy was discussed as far back as the Zurich meeting of the International Congress for Testing Materials. At that time, Dr. P. Prüssing exhibited samples containing 50 per cent. of highly expansive constituents, but so finely ground that they slaked readily, without expansion, on being stirred up with a large volume of water, though when mixed with only a little water, for the production of cement ware, considerable expansion occurred. Thus, even at that time, proof existed that a test in which the cement is mixed with much water does not always cast suspicion on such dangerous cements as those in question; and a desire arose for the introduction of some method of testing with specimens made up with only a little water (earth-damp or dry).

Experiments with various testing methods failed at that time to lead to the desired result; and in course of time other proposals were made in succession for the rapid testing of cement in order to detect any tendency to expansion. Among these may be mentioned: The Drying test at 100 degrees C. (Darrprobe), the Heintzel ball test (calcination test), the Michaelis boiling test, the Von Tetmajer ball test, the Maclay hot water test and the Prüssing pressed block test.

All these tests met with opposition, and in 1891 the Association of German Portland Cement Manufacturers gave expression to the following opinions:—

(1) The test for standard constancy of volume in Portland cement is sufficiently decisive and perfectly adequate for practical purpose, if performed with care.

(2) The accelerated tests, hitherto published, for ascertaining inconstancy of volume in Portland cement are not adapted to enable the consumer to form a reliable judgment on the cement, it being found that some Portland cements which fail to pass the accelerated tests, prove thoroughly constant in volume when in use.

On the other hand, there were loud expressions of opinion, particularly by Von Tetmajer, Bauschinger, Dr. Michaelis and C. Prüssing, to the effect that the standard tests were insufficient for judging cement, especially when the cement was intended to be exposed to the air during setting in pactical use. His opposition to its views induced the association to appoint a committee entrusted with the solution of the following question:—

Does the standard test for constancy of volume in Portland cement enable an accurate judgment to be formed on the behavior of a cement in use, or is this object attained in a more reliable manner by any of the proposed (accelerated) tests?

Without delay, the committee began operations in collaboration with the Royal Mechanico-Technical Laboratory at Charlottenburg.[1] The laboratory procured ten cements which, according to the users, had behaved satisfactorily in practice, though failing to pass the boiling test. All the cements were tested by the laboratory and by the members of the committee separately, as regarded their general properties, changes of volume in the Bauschinger tester, tensile strength and behavior under the above-mentioned tests for constancy of volume. Moreover, reliefs and conduit covers were made from the cements at the cement works for the purpose of being exposed to the air, subject to all changes in the weather during setting.

It is impossible here to go into the details of the experiments, but it must be specially mentioned that none of the so-called "accelerated" testing methods tried (drying test at 100 deg., Heintzel ball test, Von Tetmajer ball test, Maclay hot water test and Prüssing pressed-block test) appeared calculated to enable a rapid and reliable judgment to be formed in all cases as to the suitability of a cement for practical use.

The experiments showed that all ten cements which passed the standard test also exhibited constancy of volume (in the practical sense) when used for making test pieces and cement ware. The practical utility of the cements was also demonstrated by the increased tensile strength of the test pieces when allowed to harden in water and in the air.

The assumption that the standard test for judging a cement is inadequate, especially when the cement is intended, in practice, to harden in the air, failed, therefore, to obtain any confirmation through the experiments of the committee. That body, however, expressed its willingness to carry out additional experiments, and publicity requested the adherents of the accelerated methods of testing to place at its disposal sufficient quantities of such cements as passed the standard test, but failed to pass the accelerated tests and were found to expand in practice. Cements of this kind were to be forwarded to the Charlottenburg laboratory. In spite of the long term appointed, no response has been received on this matter by the laboratory, and no experimental material for testing in the above-mentioned manner has been furnished.

This might have been considered as settling the matter; but the laboratory has gone further, and has continued for years to keep under observation the cements (and the articles made therefrom) characterized as highly suspicious from the results of the accelerated tests without, however, finding any alteration in the result.

Accordingly, the assumption that the so-called accelerated tests for constancy of volume enable, in general, a more accurate judgment to be formed on the suitability of a cement than is done by the standard test should be dismissed as erroneous. Following on the experiments, however, the laboratory requested a large number of officials to keep under observation the constructional works carried out by them with cements which, according to the accelerated tests, ought to be of a suspicious character; and the results of such observations have been compared with the results of the accelerated tests on constancy of volume. This comparison established in an unimpeachable manner that numerous cements of different origin and methods of preparation, which had partially or entirely failed to pass the accelerated tests for constancy of volume, were found to have fulfilled their purpose completely, irrespective of the conditions of the mixtures, during an observation period of 34 to 18 months, without giving rise to the smallest objection in connection with their constancy of volume.

Furthermore, it has been established by a circular inquiry among more than 200 users of cement that the dubious value of the darrprobe and boiling test in particular has already been recognized in practice, and that there is no longer any need for such tests. In numerous instances it was found that testing in the standard manner sufficed completely to reveal the inferiority of a badly prepared cement. Six cements, which, on the basis of the boiling test and drying test at 100 deg. C. ought to have ranked as quite useless, have been employed, officially, for a variety of building purposes, e.g., in building a fire station; for concrete and masonry in harbor work; in abutments and circumvalliation work in a fortress; in building a high-level water tank; in the piers of a large railway bridge; for concrete floors and ceilings, etc. In all cases the work has remained under observation for several years, but in no case, however, has the work given rise to complaint on the score of changes in volume, or in any other respect, although the constancy of volume of all these cements, as determined by the darrprobe, calcination test and boiling test, was open to the gravest suspicion, and although remarkable phenomena were exhibited at the end of one and two years by the test blocks in air and water. No injurious effect could be observed in practice—in a very thick concrete wall—even in the case of a cement which was completely disintegrated by the boiling test, and showed reticulated and edge cracks at the end of two years in a test block immersed in water. The thoroughness of these observations and determinations is probably unsurpassed.

After the publication of these results the question of accelerated tests for constancy of volume slumbered for some years, so far as Germany was concerned, until Le Chatelier proposed to fill the cement paste into split brass rings fitted with needles and test the expansion by measuring the distance between the needle points after treatment in hot water. Hence the Le Chatelier test is an improved form of boiling test.

Quite recently Dr. G. Hentschel has proposed a modified boiling test for cement. Instead of performing the boiling test after the block has been hardened for 24 hours, he proposes a preliminary treatment to accelerate the hardening before applying the test. The block is to be left for 15 to 20 minutes on a highly absorbent gypsum plate, and then be heated, on an iron plate, over a naked flame until no more water vapor is given off. After cooling, it is immersed for ten minutes in water at room temperature, and is then exposed to the air for three hours, being finally boiled. It should be remarked that one cannot expect this test to furnish any essentially different information from that given by the old darrprobe and boiling test; and it will prove unreliable and misleading for the same reasons as the older tests.

Greater attention was bestowed on the Le Chatelier test, mainly because, in contrast to the other methods, it furnished values which were regarded as mutually comparable. The British Standard Committee took up the Le Chatelier test; and from England this test was laid before the International Association and caused to be accepted by the Copenhagen Congress, 1909, as a commendable accelerated test for constancy of volume, although a number of expert members protested against this decision. The protest was entered in the minutes of proceedings, and is now brought to remembrance again.

In justification of this protest, reference was made at Copenhagen to the aforesaid unfavorable experiences with the boiling test. It must be reiterated that the Le Chatelier test is a boiling test, and therefore must also be judged, like the old boiling test, on the basis of the comprehensive experiments already referred to. Moreover, it is necessary to point out the opinion in which this test is held even in England.

At a meeting of the Concrete Institute in 1910, Mr. Butler read a paper on tests for constancy of volume, which paper was followed by an extremely animated discussion. The reader of the paper supplemented a historical review of the development of the existing tests by an exposition of the theoretical advantages of the Le Chatelier test; but on the basis of many thousand experiments with the Le Chatelier needle came to the conclusion that, owing to the often contradictory results in cases where the cements would have to be condemned on account of failure to pass the Le Chatelier test, the results must not be interpreted too strictly. He also demonstrated that divergent results could be obtained in different localities, and that the results also differed even

when the tests were performed at one and the same place and under perfectly identical conditions. It is highly interesting and characteristic of the lack of practical value of the test that the results of Butler's experiments entirely coincide with the experiments (to be mentioned later) carried out by the Association of German Portland Cement Manufacturers. Butler found:

In the first place, that with three operators working in the same place and with the same molds, the results of the tests showed extreme divergences. One operator found considerable expansion of the cement, whilst the other two found much less expansion. According to the result of the one test, the cement would have to be discarded as not being constant in volume; whereas, on the basis of the results obtained by the other two, under precisely equal conditions, the cement was not open to objection.

In the second place, Butler found that an extraordinary influence on the results was exerted by the use of different kinds of needles, whether brass or copper, old or new.

Thirdly, he found that on many occasions the test pieces gave higher expansion values after the cement had been exposed to the air for 24 hours or 6 days than when the same cement was used in the original conditions. He points out that, in the English method, the expansion during the first 24 hours—which in many cases is far greater than the subsequent expansion—is entirely neglected by the boiling test, and that leaving the cement 24 hours to harden before boiling is quite an arbitrary procedure.

At the conclusion of the paper, the author said that, whatever good reasons might exist, either in favor of or against accelerated tests for constancy of volume, he could vouch, from his personal experience, for the fact that not 90 per cent. of the Portland cement made in England or elsewhere less than 20 years ago would have been able to pass the boiling test under the conditions laid down. If this test were indeed an accurate one for constancy of volume, the evident conclusion would be that 90 per cent. of the total cement used 20 years ago was not constant in volume. This would be a somewhat surprising assumption when it was remembered that hundreds of thousands of tons had been used for important structures in different parts of the world; and in view of the excellent present condition of these structures, the assumption could not be seriously brought forward.

This paper was read at a meeting under the chairmanship of Mr. Blount, the advocate of the Le Chatelier test at Copenhagen. Mr. Blount's criticism of the paper was that he did not agree with Mr. Butler. This terse but unfortunately, merely ex parte opinion was, however, not shared by a large number of well known English cement manufacturers, who expressed their agreement with Mr. Butler. Among others, objections were raised against the Le Chatelier test by Messrs. Bamber, Cooper, Tristam, Watson and Roberts.

So far as the Association of German Portland Cement Manufacutrers is concerned, the Le Chatelier test was first tried, in 1909, by a special committee, under the chairmanship of Director Schindler. It appears from the comprehensive report that, as was found by Butler, there was no harmony between the results obtained at different testing stations. The experiments were continued, on a larger scale, in 1910 with six cements. The results were most contradictory, one and the same cement giving expansions varying between 0 and 10.7 mm. of needle divergence at different stations. Schindler's report contains all the individual values and careful drawings of the results at ten testing stations.

At the Royal Laboratory for Testing Materials, experiments were carried out in 1911 with six Le Chatelier needles, of different kinds of brass and copper, and the experiments, like those of Butler, show that the results of the Le Chatelier test vary according to the kind of material and method of making the needles.

Consequently, the apparatus is, in itself, uncertain and unreliable.

Finally, under the chairmanship of Dr. Strebel, committee No. V. of the German Association for Testing Materials, made a thorough investigation of the Le Chatelier test, and Dr. Strebel presented his report to the twelfth general meeting of that association held in Düsseldorf on October 7, 1911.

The experiments led to the following conclusions:

(1) It has been found that the Le Chatelier test characterized as constant in volume a cement which exhibited a decided tendency to expansion in cold water. Even if the cement in question be one of abnormal composition, it was, nevertheless, bought in the open market; and consequently the buyer of such cement would, if he relied on the results of the Le Chatelier test, have incurred risks by using the cement in practice.

(2.) It was also found that the results obtained in testing one and the same cement in different testing stations varied in such a manner that in quite a number of instances a cement would pass the test in some stations but not in others. The risks arising from such unreliability on the part of an extremely important test do not need to be enlarged upon. The matter is rendered more serious by the fact that the tests in question were performed by skilled operators exclusively, and in strict accordance with the prescribed conditions.

Owing to the coincidence of these results with all those obtained in the previous experiments, the committee—comprising not only manufacturers, but also a large number of the most prominent cement experts in Germany—decided to invite the German association to adopt the following resolutions:—

(1.) The German Association for Testing Materials rejects the Le Chatelier test as an accelerated test for constancy of volume.

(2.) The Association requests the International Association for Testing Materials to set aside the resolutions adopted at Copenhagen with reference to the Le Chatelier test.

At Copenhagen it was evident that the German cement industry would have to fight shy of the introduction of the Le Chatelier test, and that the resistance offered to this test by the German members was based on that circumstance. On the other hand, it should be mentioned that already in 1909 experiments with the Le Chatelier test were carried out in the laboratory of the Association of German Portland Cement Manufacturers, as reported by Dr. Framm in 1910. According to the English regulations, the expansion of the test pieces (cement not exposed to air) should not exceed 10 mm. after six hours' boiling. This condition was fulfilled by 83 samples out of 88 German commercial cements, originating from 88 different makers, 79 of the samples giving an expansion of less than 5 mm. and only 4 samples one, between 5 and 10 mm. The mean expansion of the entire set of samples, including those which failed to pass the test, was only 3.5 mm. This shows that if the Le Chatelier test gave reliable results, the Germans need not fear its introduction. It is, however, rejected because the result of the test is uncertain and bears no relation to the other properties of the cement.

Basing on the foregoing unassailable facts, I arrive at the following conclusions:—

The decision of the Copenhagen Congess to commend the Le Chatelier test as accelerated test for constancy of volume is not borne out by the facts of the case. The Le Chatelier test is misleading and should therefore be discarded.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD
MARINE AND MINING ENGINEER, THE SURVEYOR,
THE MANUFACTURER, AND THE
CONTRACTOR.

Present Terms of Subscription, payable in advance
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (7s.)	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, MARCH 20, 1913. No. 12.

CONTENTS OF THIS ISSUE.

THE SMOKE PROBLEM.

A most difficult problem to satisfactorily solve in cities is the pollution by smoke of the atmosphere. It may be merely an unpleasant and jarring note on the beauty of the scenery to the suburban residents, but it has an added and more serious meaning to those living in the smoke area, and that usually means a majority of the citizens.

A certain amount of dust and impurities from the streets will always of necessity be found in the city atmosphere. The presence of such is a menace to health, and every added pollution by smoke only further endangers the public's well-being. All these points are well known, and pressure has in a way been brought to bear on the scientist to in some way abate the nuisance.

Legislation, it would seem, is the only way to cure the evil, and that involves the interruption and interfering with of long-used rights. Without knowledge and accurate data of the exact amount of smoke pollution in our towns, legislation on the subject is extremely difficult, and there must ultimately devolve on engineering shoulders the task of gathering these data.

Any attempt so far at the abating of the smoke nuisance or of obtaining information on the subject seems to have been local and confined to independent municipal effort. There is no organized effort in Canada to systematize and collect smoke information. Vancouver, for instance, in a recent report to the City Council, by a Smoke and Sawdust Abatement Society, recommended as follows:—

That the offer of a public service corporation to supply the city electric light, heat and power for consumers by developing electricity and steam heat from lumber refuse be accepted. The franchise to the company was to be for thirty years. Besides relieving the city of part of its smoke, consumers were to be supplied with energy at the following rates: electricity at eight cents per kilowatt hour, and subsequently seven and six cents; heat at $1.00 per 1,000 pounds of steam pressure development. The company was to pay the city one per cent. of gross earnings the first ten years, two per cent. gross the next five years, and two and a half the succeeding five years. The company was also to start operations within fifteen months and to expend $50,000. Now the above contract is very interesting, and might help Vancouver in its smoke trouble, but it is questionable whether a remedy on such lines would be practicable in other cities. Vancouver in being a city of many lumber mills has possibly sufficient waste product available for fuel to make such an attempt possible. The majority of Canadian cities and towns have not that resource. It is legislation that will help all municipalities that must be hoped for as the desired goal.

In England a committee of scientists have been appointed who have formulated a plan of investigation that ought to lead to more definite information of the pollution of atmosphere than we have yet had. All the principal local authorities of the United Kingdom are to be communicated with in the hope that they will co-operate in an organized attempt to collect reliable data as to the degree of the pollution of the atmosphere in different places. No co-ordinated effort has ever previously been made to estimate the amount of suspended matter in the air. A standardized method of examination of the atmosphere is to be adopted, and the result ought to be the collecting of much useful information. The standardized method of investigation is to be (a) a form of enlarged rain gauge, with catch area of four square feet, and a large bottle is provided to collect rain, soot, or other

deposits falling. The bottle is removed periodically and the amount of solids estimated. This is a method for use over long periods.

(b) A measured volume of air drawn through filter paper is the method for measurements of solids from day to day or hour to hour.

One cannot help feeling that such a systematized course of investigation should be inaugurated in Canada as well as Great Britain. It is only through reliable knowledge of conditions gained by such means that we can ever hope to be able to effectively handle the problem. It is only when the exact amount of the pollution of atmosphere we are undergoing is known; when we have some idea based on facts of the amount of injury to health dwellers in the cities are risking. It is only then that corrective legislation will be properly balanced.

Tampering with rights of usage and time by regulations which might seriously affect vested capital is too serious a problem to be encouraged without full knowledge of the conditions to be remedied. We would probably either allow more pollution than is good for us, or go to the other extreme and be unnecessarily harsh in our regulations if we approached the subject in any other manner. Active steps should be taken in Canada to gather information and data on smoke pollution similar to those being carried on in the United Kingdom. It is a step towards better laws that we should all hope to see.

SPONTANEOUS COMBUSTION.

The liability of coal in bulk to take fire from spontaneous combustion is generally known among the engineering profession. The chemistry and cause of the action may not be so familiar to many of our readers. Possibilities of fire due to chemical action taking place between the air and the coal is well understood by chemical engineers and by those accustomed to handling or using coal in bulk. It is a question which has been well treated in an article on another page of this issue by the owner of gas works who had suffered considerably in a business way due to fires brought on by spontaneous combustion. The subject, moreover, has peculiar significance just at present, due to the recent catastrophe at Baltimore, whereby a ship that was loading dynamite was blown up and forty or fifty people killed. While there is no official version of the cause of the explosion, it was apparently due indirectly to fire generated by spontaneous combustion in the coal bins. Accounts that come of the length of time between the discovery of the fire until the actual explosion took place lead one to believe that the dynamite was not the original source of trouble. Moreover, fire otherwise located than in the bottom of the coal bunkers, would probably be quickly observed and extinguished before it was too late to prevent the explosion of dynamite. Everything considered, it seems reasonable to blame the coal bunkers and spontaneous combustion as the cause of the catastrophe. One can be glad that reason and charity go together to support the belief that unforeseen and unguarded chemical actions were the cause of the accident rather than pure human carelessness.

The whole subject of the explosion can be understood by a study of the previously mentioned article. Coal, it appears, absorbs from one to three times its volume of oxygen. This produces heat, and, occurring in a thick mass, the heat accumulates, and ignition is the result. It seems a disputed point, according to Mr. Kendrick, whether free ventilation should be aimed at to prevent combustion, or whether the method whereby no warm air is to be allowed near the coal, and so no heat generated, should be adopted. The latter method being true, it is quite safe to store coal in closed bunkers, exhaust the air at the top and fill the voids between the coal from below with carbon dioxide.

Coal of large size with few fines in it will ordinarily not take fire. Nevertheless, Mr. Kendrick claims that in coal mines ample ventilation has sometimes caused heating in the gob (waste fillings in mine), and choking off the air current has stopped the heating. Water is not very satisfactory for quenching coal piles that are on fire if in small quantities, and may, if so used, only increase the combustion and heat. One can understand, therefore, how, in a ship loaded with dynamite, fire, once well started in a coal bunker, might be inextinguishable when discovered before the serious danger of the fire had extended to the dynamite.

Knowledge has forearmed man sufficiently against spontaneous combustion, so that, ordinarily speaking, he should be able to guard himself against serious danger from it. With proper attention during loading, or with a proper system of inspection afterwards, a ship carrying dynamite could be made safe from such an occurrence as spontaneous combustion. It is unfortunate that it is usually tramp steamers that carry the most dangerous cargoes around. The officers and crew may not be in a position to either know how or to be able to enforce intelligent and scientific orders and inspection for the prevention of accidents. It will be interesting to note what steps, if any, will be taken to prevent a re-occurrence of such an accident as that brought about by spontaneous combustion occurring in coal bins of a ship loaded with dynamite.

EDITORIAL COMMENT.

The arrival of Easter brings to end one of the mildest winters Ontario has ever experienced. The corollary follows that it has been an exceptionally fine winter for those trying to carry on outdoor work or building construction. Winters of such a mild nature as that just past are always welcome to engineers. The cold is a serious drawback to all forms of construction, and the arrival of spring, we hope, heralds the approach of a summer of unexampled activity in all engineering lines. Railroads under construction and extension; the Welland and Georgian Bay Canal schemes; harbors in almost all our Canadian cities under plans for improvements and increased shipping accommodation. All these items and many smaller ones go to make up a gigantic programme to prepare for and consider in an engineering way.

LARGE WIRE ROPE.

A large cable which has been used for 18 months in lowering 50-ton trucks down an incline into a mine in Cuba has been tested at Lehigh University, Pa. A portion of the worn cable withstood a test of 300 tons. The cable itself is believed to be unique in wire rope manufacture; it consists of six strands, each having 19 wires, placed around a wire rope centre, and the centre is composed of six strands of 19 wires each twisted around a hemp rope. The length of the cable was 7,810 feet, and it weighed over 125,000 lbs.

ELECTRIC RAILWAY STATISTICS.

The growth of electric railways throughout Canada is well shown in the following statistics, published by the Department of Railways and Canals, Ottawa. Two companies failed to make their annual report to the Department for 1912, i.e., the Montreal Tramways and the St. John Electric, consequently, in the statistics given for 1912 it has been necessary, as regards the above-mentioned companies, to assume the figures from their 1911 reports as applicable to the following year.

Operations for the year show growth in all departments and a general extension of the electric railway interests.

Mileage.—Track mileage for the past four years is shown in the following table:—

Length of Tracks.	1910. Miles	1911. Miles	1912. Miles
Length of first main track	1,049.07	1,223.73	1,308.17
Length of second main track....	242.39	259.74	294.50
Total length of main track.....	1,291.46	1,483.47	1,602.67
Length of sidings and turnouts..	91.39	103.54	120.84
Total, computed as single track.	1,382.85	1,587.01	1,723.51

It will be observed from the foregoing that there was an increase of 84.44 in first track mileage, and of 34.76 in second track mileage—a total for 1912 of 119.20. The increase in sidings and turnouts amounted to 17.30 miles. The actual gain for the year in trackage of all sorts was 136.50 miles.

For purposes of comparison, the following table shows first track mileage since 1910:—

1910	1,047.07
1911	1,223.73
1912	1,308.17

Improperly included double track and sidings.

Capital Liability.—There was an increase for 1912 of $11,309,599 in capital liability, which brought the total up to $122,841,946.

The facts with respect to capital liability since 1910 are as follows:—

	1910.	1911.	1912.
Stocks	$ 58,653,826	$ 62,251,203	$ 70,829,118
Funded debt	43,391,153	49,281,144	52,012,828
Total	$102,044,979	$111,532,347	$122,841,946

The foregoing statement does not include cash subsidies to the amount of $493,346 received from governments and municipalities.

Earnings and Operating Expenses.—Gross earnings from operation in 1912 totalled $23,499,250.31—an increase of $3,142,298.61 as compared with 1911.

Following were the sources and items of gross earnings for the year:—

Car earnings—	
Passengers	$22,007,750.15
Freight	1,025,371.93
Mail and express	78,818.66
Other car earnings	67,022.30
Total car earnings	$23,178,693.04
Miscellaneous earnings—	
Advertising	$ 71,226.65
Rent of land and buildings	21,228.39
Rent of tracks	13,836.70
Rent of equipment	56,239.74
Sale of power	37,083.98
Other miscellaneous earnings	120,671.81
Total miscellaneous earnings	$ 320,287.27
Gross earnings from operation	$23,499,250.31

A comparative statement of car earnings for the past three years shows the following result:—

Gross car earnings.	1910. $	1911. $	1912. $
Passengers	16,125,944.72	19,130,370.22	22,007,750.15
Freight	575,536.84	744,179.11	1,025,371.93
Mails and express	68,604.11	88,233.13	78,818.66
Other earnings ..	51,241.07	100,930.12	67,022.30
Total	16,821,376.74	20,063,718.58	23,499,250.31

An outstanding feature in the foregoing statement is the steady rise of earnings from freight. In 1904 there had been an increase to $182,143, and in 1906 to $288,105. In 1912 the earnings from freight reached $1,025,372—showing the extent to which that aspect of public service had grown in twelve years.

Table 4 will afford details with respect to earnings.

Following is the balance sheet for 1912:—

Earnings and income—		
Gross earnings from operation		$23,499,250.31
Operating expenses		14,266,674.63
Net earnings		$ 9,232,575.68
Miscellaneous income		1,617,017.78
Gross income		$10,849,593.46
Deductions from income—		
Taxes	$1,581,802.81	
Interest—funded debt	1,570,202.02	
Interest—floating debt	193,068.26	
Other deductions	188,582.57	
	$3,533,655.66	
Undistributed	1,378,906.56	4,912,562.22
Total net income		$ 5,937,562.24

The undistributed amount given above relates to the British Columbia Electric Railway Company, which operates, in addition to an electric railway, a lighting and power plant. A separation is not made in the balance sheet of that company of items which would establish the real net income of the electric railway interest by itself.

If the undistributed income had been added to net income, as was done in preceding years, the amount of the latter for 1912 would have been $7,315,937.80, as compared with $6,592,535.30 in 1911. It would not, however, be strictly correct to do that, since it represents a total from which proper deductions had not been made. The definitely known net income is the sum given in the balance sheet, although it is probably below the actual amount.

The amount of dividends and bonuses paid during the year was $4,229,005.75. These payments were equal to 5.9 per cent. of the total stock issue.

Following is a comparison of deductions from income for the past three years:—

	1910.	1911.	1912.
Taxes	$1,311,953.65	$1,437,045.07	$1,581,802.81
Int. on funded debt	1,449,152.48	1,622,780.11	1,570,202.02
Int. on floating debt	156,546.16	157,843.38	193,068.26
Other deductions ..	36,106.97	155,149.97	188,582.57
Total	$2,953,759.26	$3,352,818.53	$3,533,655.66

Operating expenses for the year totalled $14,266,674.63 as against $12,096,134.22 in 1911.

The ratio of operating expenses to gross earnings was 60.71 per cent., as compared with 59.42 in the preceding year.

Following was the distribution of operating expenses in 1912, with a comparison for 1911:—

Operating expenses.	1911.	1912.
Maintenance of way and structures	$ 920,874.93	$ 1,228,972.10
Maintenance of equipment	1,758,289.10	1,859,939.21
Operations of power plant	2,001,543.00	2,535,573.10
Operation of cars	5,768,085.10	6,770,560.47
General	1,610,098.62	1,871,626.75
Total	$12,096,134.22	$14,266,674.63

Following is a comparative statement of the items comprising operating expenses for the past three years:—

	1910.	1911.	1912.
Maintenance of way and structures—			
Track and roadway	$ 590,363.28	$ 693,498.75	$ 857,796.61
Electric line	152,874.47	163,108.91	227,562.04
Build'gs and fixtures	54,657.28	64,697.11	143,613.40
Maintenance of equipment—			
Steam plant	38,305.93	46,504.31	50,137.15
Electric plant	45,148.10	65,145.02	87,570.70
Cars	692,276.38	790,609.02	916,755.20
Electric equipment of cars	481,301.83	546,276.52	630,521.52
Miscellaneous equipment	58,815.63	99,831.25	86,053.80
Miscellaneous shop expenses	202,591.58	192,608.03	67,493.89
Transportation—Operation of power plant—			
Power plant wages	178,389.69	207,118.54	205,858.34
Fuel for power	271,410.36	332,584.89	315,019.83
Water for power	21,398.33	21,947.47	13,979.30
Lubricants and waste for power plant	10,538.93	10,702.75	11,006.39
Miscellaneous supplies and expenses	17,916.34	29,120.20	22,051.25
Hired power	1,087,273.72	1,390,810.05	1,901,757.49
Transportation—Operation of cars—			
Superintendence	192,567.60	250,459.73	319,399.37
Wages of conductors	1,749,916.70	2,070,624.01	2,423,060.35
Wages of motormen	1,697,096.68	2,024,115.38	2,371,529.39
Wages, miscellaneous car service	152,950.35	294,498.67	339,771.00
Wages, car house employees	393,998.76	287,441.56	400,967.61
Car service supplies	94,486.16	151,489.64	161,895.17
Miscellaneous car service expenses	183,526.94	306,931.96	304,898.48
Hired equipment	42,136.56	55,278.55	73,876.17
Cleaning and sanding track	65,200.30	80,302.13	86,514.84
Removal of snow and ice	238,881.58	246,043.47	285,662.53
General—			
Salaries of general officers	236,575.70	279,819.40	327,451.09
Salaries of clerks	202,712.98	250,902.23	274,832.47
Print'g and stationery	33,634.34	44,284.36	53,073.13
Miscellaneous office expenses	44,336.11	34,944.72	54,474.14
Stable expenses	30,817.44	33,047.06	47,031.82
Store expenses	33,841.10	37,876.19	43,908.89
Advertising and attractions	47,411.04	49,948.03	30,706.15
Miscellaneous general expenses	133,752.32	165,707.31	154,432.11
Damages	342,120.26	357,270.67	536,273.01
Legal expenses	8,784.32	9,107.93	4,406.14
Miscellaneous legal expenses	54,336.64	63,311.08	53,089.47
Rent of land and buildings	20,936.74	28,310.05	29,651.68
Rent of track and terminals	98,753.70	110,846.74	90,751.33
Insurance	118,930.80	144,713.85	148,309.34

Public Service.—During the year 488,865,682 passengers were carried, exclusive of 125,453,320 transfers, showing an increase of 62,568,890 as compared with 1911.

The carrying of these passengers involved a car mileage of 80,402,089. Freight, mail, and express business had a car mileage of 1,667,975. There was an increase of 8,867,961 in passenger car mileage, and 583,297 in freight car mileage, over 1911.

The following statement shows the growth of passenger traffic since 1910:—

1910	360,964,876
1911	426,296,792
1912	488,865,682

The number of tons of freight hauled was 1,435,525, as compared with 1,228,362 in 1911. Owing to an erroneous return in 1911 by one of the Ontario companies, the figures published in that year in relation to freight tonnage were considerably exaggerated.

Equipment.—The following statement will show the number and classes of cars in service in 1912, with the figures for the two preceding years:—

Classes of cars, etc.	1910.	1911.	1912.
Passenger, closed	1,795	1,985	2,049
Passenger, open	994	990	866
Passenger, combination	337	455	574
Freight	282	357	483
Mail, express and baggage	25	33	33
Combination, passenger and freight	-	5	7
Work	[illegible]	108	[illegible]
Snow ploughs	[illegible]	60	57
Sweepers	97	106	112
Miscellaneous	103	225	194
Total	3,789	4,325	4,478

Employees.—The number of employees in the service of electric railways on June 30, 1912, was 14,760, as compared with 13,671 in 1911.

The total of salaries and wages for the year was $9,261,370.26, as against $8,559,215.04 in 1911.

Salaries and wages in 1912 were equal to 64.91 per cent. of the operating expenses, as compared with 70.76 in the preceding year.

The following comparative table will show the number and classes of employees in 1912 and 1911:—

Employees.	1911.	1912.
General administration—		
General officers	163	159
General office clerks	694	744
Maintenance—		
Superintendents	89	90
Other employees	4,546	4,922
Transportation—		
Superintendents	111	118
Other employees	8,157	8,727
Total	13,671	14,760

WESTERN CANADA POWER COMPANY'S HYDRO-ELECTRIC PLANT AT STAVE FALLS, B.C.

One of the most important hydraulic installations Messrs. Escher Wyss and Co., of Zurich, Switzerland, have installed in Canada is the Stave Falls plant of the Western Canada

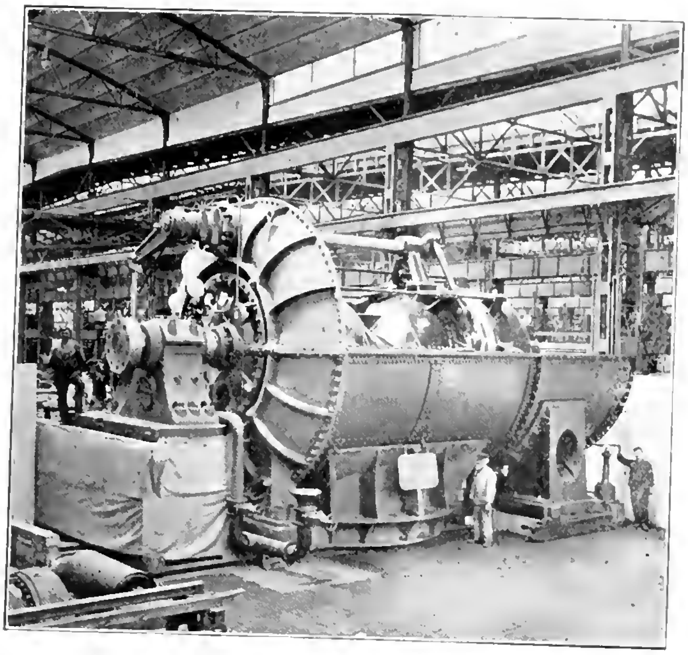


Fig. 1.—13,000 H.P. Turbine, rear view.

Power Company. The power station is located about 35 miles from Vancouver at the Stave River Falls and utilizes a fall of about 100 feet.

By building two dams at the upper side of Stave Falls a large reservoir has been created reaching to the upper end

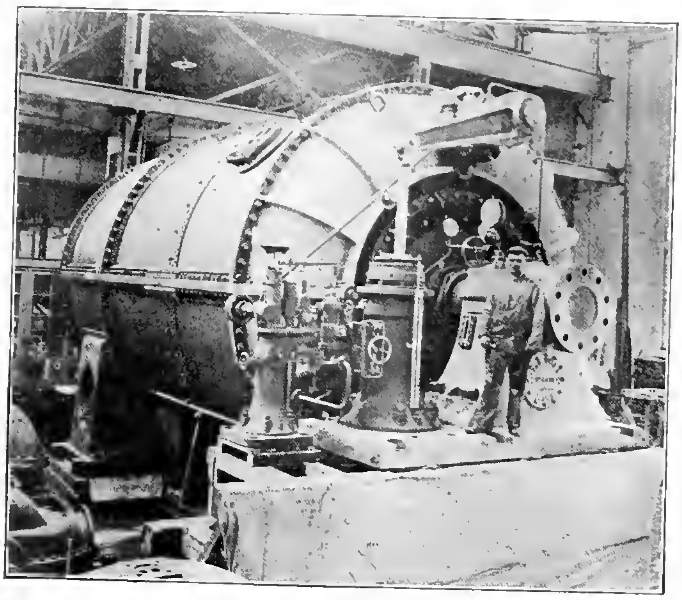


Fig. 2.—13,000 H.P. Turbine, Front View.

of Stave Lake, a distance of 16 miles, with an area of 18 square miles; this storage capacity, together with the flow of the river, is sufficient for 28,000 h.p. continuously, and for a peak load of 50,000 h.p.

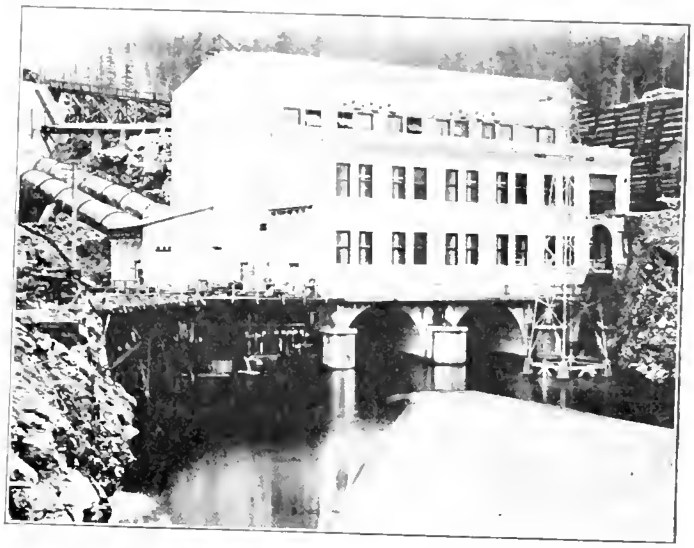
By raising the dams additional storage can be obtained and the plant be brought up to the full capacity of 100,000 h.p.

At present 26,000 h.p. are developed and two units of 13,000 h.p. are installed. The water is taken from a forebay by means of two penstocks, each having 14'6" diameter and a total length of 150 ft. The penstocks for the two exciter turbines are 4 ft. in diameter.

The design of the main turbines is shown on figures 1 and 2. These turbines are of the Francis type with horizontal shaft, double wheels and central discharge, delivering through a short draught tube formed in concrete to the tail-race. The level of the water in the tail-race is kept constant at elevation 110 ft. The level of the water in the forebay varies from a minimum of 210 ft. to a maximum of 230 ft., the head varying thus from 100 ft. to 120 ft. The average head is 110 ft. Under this head the turbines have to give a maximum power of 13,000 h.p. on the shaft when running at a speed of 225 r.p.m.

Regarding the design, the following remarks may be of interest:—

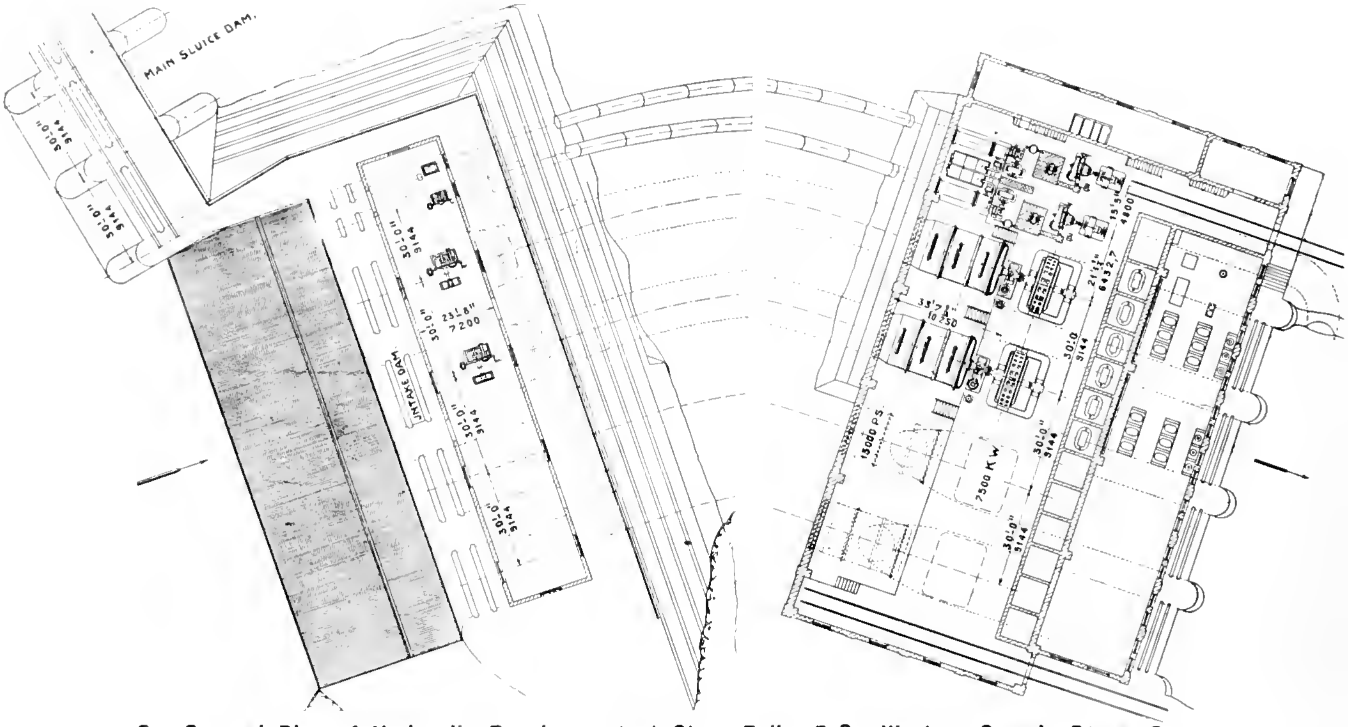
The wheel casing is made of steel plates with heavy steel angles; it is divided horizontally so that the upper part can be removed for easy access to the turbine. Heavy angle irons stiffen the casing so that it cannot spring out of shape



Power House, Stave Falls, B.C., Western Canada Power Company.

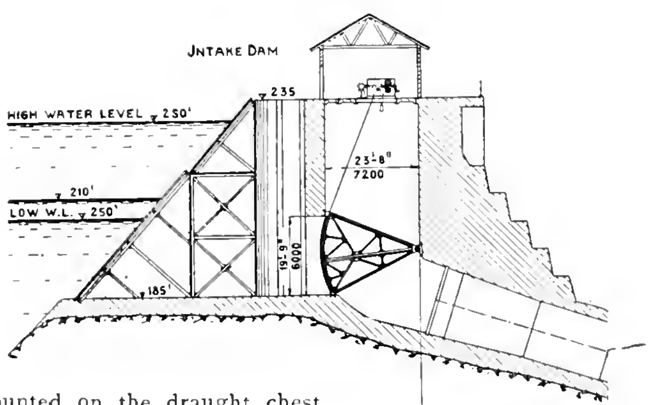
when taken apart. To connect the casing to the penstock a taper piece is inserted. The main cover is made of cast steel, strong enough to withstand a pressure amounting to twice that due to the static head. The bearings are of very large dimensions, the generator bearing being arranged in such a way that it can be sunk by taking out an intermediate piece under the pedestal so as to allow for dismantling of the shaft. The outer bearing is protected by a housing, into which access is allowed by means of a steel tube. It will be noted that a considerable distance between the two bearings is allowed, but Escher Wyss and Company consider this arrangement better than to have a third bearing inside the draught chest which is not free to inspection and thus means a weak point in the design. The shaft is made in one piece and of sufficient thickness at the centre to revolve without the support of a middle bearing and without undue deflection. The half couplings are forged on both the generator and the turbine shaft. A strong cast iron foundation frame supports rigidly the draught chest and cover. No steel girders are used as foundation, but the whole is grouted in concrete. The runners are made entirely in cast steel. Considerable difficulty was experienced by the steel foundries to cast these runners, but in the end faultless casts were obtain-

ed and the high efficiency these runners have shown gives high credit to the designers. The guide vanes are of cast steel, and all steel bolts are provided with suffing boxes and bronze bushings so as to guarantee smooth working and possibility of dismantling. The regulating rings have been



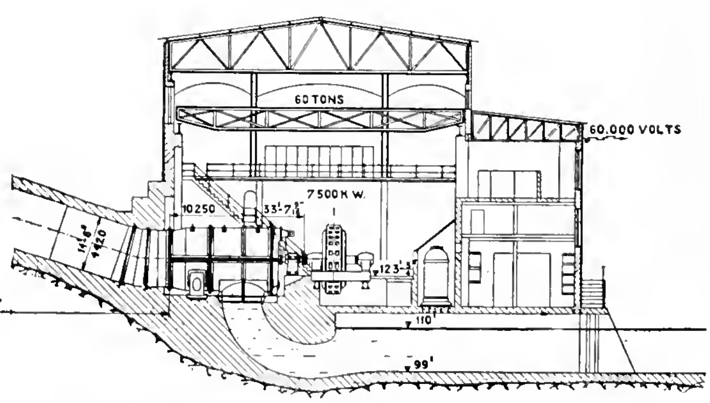
C.—General Plan of Hydraulic Development at Stave Falls, B.C., Western Canada Power Co.

given a profile of maximum possible resistance and stiffness, which in this case is of great importance, as the diameter of the ring is 9 ft. These rings, as well as all covers, stuffing boxes, etc., are split horizontally. A regulating shaft of 10 inches diameter, supported by white metal bearings



mounted on the draught chest, operates the regulating rings. The shaft, on the other hand, is operated direct from the servo-motor working under oil pressure supplied by an oil pumping plant. The speed governor is driven by belt from the main shaft. The servo-motor consists of a differential cylinder, which, by means of pressure oil from the air vessel produces the power required for moving the governor gearing of the turbine. Pipes from wither side of the piston connect to the controlling valve mounted on the casing. This valve contains several chambers communicating with the respective servo-motor chambers and oil tank. The spring pendulum contains fly-weights loaded by compressed springs. The larger springs are supported by the pendulum casing, the smaller ones by the movable discs, which latter are adjustable in the radial direction, whereby the compression of the springs and therewith the speed of the pendulum is varied. The speed can be regulated by turning a handwheel on the governor or from the switchboard by means of a small electric motor mounted on the pendulum. The pendulum shaft is driven by worm wheels from the horizontal shaft, which latter is driven by belt from the turbine shaft. The movement of the fly weights in the pendulum is transmitted to the regulating lever. A relay consisting of a dash pot serves as second compensation device. Governing by hand can be effected by means of a hand governing valve, which admits pressure to one or the other side of the servo-motor piston. The oil pressure necessary for the governors of both turbines is supplied by an independent plant.

POWER HOUSE.



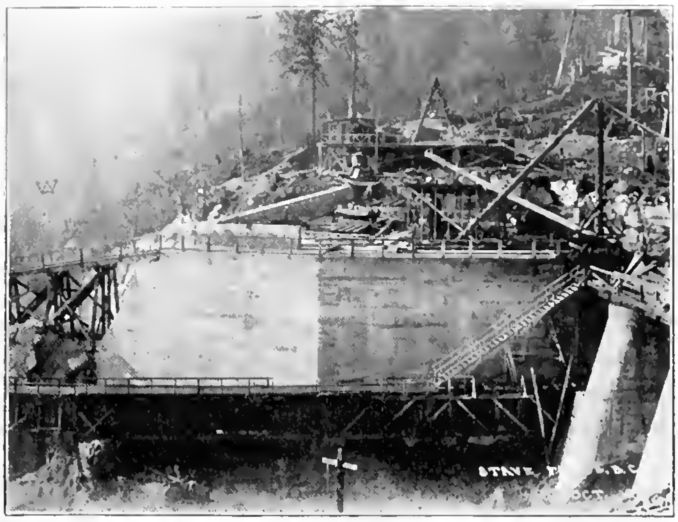
D.—Elevation and General Plan of Hydraulic Development at Stave Falls, B.C., Western Canada Power Co.

It consists of two complete units, each unit being capable of supplying under normal conditions the necessary pressure oil for the governors of the two main and the two ex-

citer turbines. Each unit consists of an impulse wheel direct connected to a three cylinder single acting oil pressure pump which draws the oil from an oil tank and forces it into a strong air chamber, whence the governors of the turbines are fed. After leaving the governors the oil is flowing back to the oil tank passing an oil filter. The impulse wheels receive water through pipes connected to the exciter pipeline.

The exciter turbines are single wheel Francis turbines with horizontal shaft in spiral casing, each designed for 500 b.h.p. when running at a speed of 500 r.p.m. They are fitted with Escher Wyss and Co.'s patent universal oil pressure governor of the standard type, and are direct connected to two exciters.

The electrical equipment of the power station, which was supplied by the Canadian General Electric Co., consists of 2 generators having a nominal capacity of 7,500 k.w. each and 2 exciters rated at 250 k.w. each. They are capable of giving a continuous overload of 25 per cent. and are producing continuously 9,375 k.w. at a power factor of 85 per cent. The normal voltage is 4,000, periodicity 60 cycles. They are guaranteed to run at a speed of 75 per cent. in excess of the normal.



Intake of Stave Falls Plant, Western Canada Power Co.

The transmission lines from the power house to the receiving station is designed for 60,000 volts.

The weight of the water-wheels is 165 tons per piece, while the generators weigh 160 tons each.

The plant was first started up in December, 1911, and, according to a statement made by the Western Canada Power Co., not the slightest difficulty was experienced, neither on the hydraulic nor the electrical machinery. It has during the fourteen months run given full satisfaction in every respect.

Modern research has brought to our industries, at a marvellous rate, not only new compounds but even new elements. Prof. H. T. Kalmus, of Toronto, calls attention to the fact that of the fifty metallic elements now known only seven were in commercial use 2,000 years ago and until 100 years ago the rate of addition was less than one metal for each two centuries. Within the last twenty-five years about fourteen metals have been added to commercial use—an addition at more than one hundred fold the previous rate.

IRRIGATION SURVEYS AND WATER POWERS.

The magnitude of the work which the Commissioner of Irrigation for the Dominion Government of the Provinces of Alberta and Saskatchewan is doing may not be altogether realized by readers who have not come in direct touch with this department. The work is carried on under the Director of Forestry, and the annual publication of the department contains many interesting details submitted by the Commissioner, F. H. Peters, A.M. Can. Soc. C.E., D.L.S. Those portions of his report which are likely to be of interest to our readers are condensed in the following paragraphs:—

The irrigation office may be said to be the guardian of the water resources of the provinces of Alberta and Saskatchewan, and this naturally carries with it great responsibilities. Much of the work done by this office must necessarily be for the benefit of future generations, and this, unfortunately, does not tend to make the work popular with the people of to-day. This is especially true of the work of stream measurement that is being carried on, and, because there is plenty of water for everybody to-day, even the most interested parties, who are themselves licensed by the government to use water, do not appreciate the work and do not realize that a perfect system of stream measurement means a perfect safeguard to their water-rights in the future, and that every dollar spent to-day in prosecuting this work means many dollars saved in the future in the prevention of litigation that must arise if the load that is placed on every stream is not carefully guarded to-day. Our neighbors to the south have learned this lesson by costly and bitter experience, and we may, if we will, profit by their experience and avoid the mistakes which they made during the earlier days of irrigation development.

General Information Regarding Irrigation in Alberta and Saskatchewan.—The irrigation office has jurisdiction over all water-grants made in the provinces of Alberta and Saskatchewan (except grants for water-power purposes, which are handled by a separate branch), and it can be easily understood that the patrolling of this vast area requires a large staff and a sound organization.

The remarks here following relate almost entirely to the work of irrigation inspections. The work done by this office naturally divides itself into two separate branches: irrigation inspections, together with reservoir site surveys, etc., and the stream measurement work. The two are closely associated and must go hand-in-hand, but are submitted separately in order to keep down the bulk of each volume, and also because the report of progress of stream measurements is nearly all composed of tables of gauge-heights and discharges, and is more fittingly published in a separate report for convenience of reference; a brief, general report on stream measurements is, however, appended hereto.

In order to give an idea of the extent to which irrigation is now being carried on in the western provinces the following brief summary is given:—

The total amount of water granted by the Dominion Government in the two provinces is 23,865 cubic feet per second. Of this total amount 23,536 c.f.s. have been granted for purposes of irrigation, leaving 329 cubic feet per second divided up between the other three classifications; that is, domestic, industrial and other purposes.

In Alberta the total amount of water granted for irrigation purposes is 23,114 c.f.s., or enough to irrigate 3,467,100 acres of land, according to the authorized duty of water, which is 2.023 acre-feet per acre.

Of this quantity four large companies have 22,500 c.f.s., leaving 614 c.f.s. divided up among 320 individual users; excluding from these twenty-four applicants who each have an average grant of about eight c.f.s., we get figures for the average individual water-user, viz.: 414 c.f.s., divided

up between 296 individual users, which gives each one 1.40 cubic feet per second, or enough to irrigate 210 acres of land.

Of the four large companies mentioned above, the following facts may be stated: The Canadian Pacific Railway Irrigation Company has been granted from Bow River, near Calgary, 3,000 c.f.s. at low-water stages, 13,000 c.f.s. at high-water stages, and 15,000 c.f.s. at flood stages. It has approximately one million acres of irrigable land, and already has issued over 1,500 agreements to furnish water to settlers within this tract.

The Alberta Railway and Irrigation Company has been granted from Belly River 500 c.f.s. at all stages of flow, from Milk River 500 c.f.s. at low-water and 1,500 c.f.s. at high-water and flood stages, and from St. Mary River 500 c.f.s. at low-water and 2,000 c.f.s. at high-water and flood stages. It should be noted, however, that the total amount of the grants from Milk River and St. Mary River have been somewhat modified under the terms of the International Waterways Treaty recently made between Canada and the United States. This company has already issued water agreements to over 800 water-users.

The Southern Alberta Land Company has been granted from Bow River 2,000 c.f.s. at high-water and flood stages, and from the South Saskatchewan River 1,000 cubic feet per second at all stages. This company has developed a very large reservoir for the storage of flood waters, in order to utilize its high-water and flood license from Bow River. The works are not yet completed, and, therefore, the company has not as yet entered into any agreement to supply water to actual users. The company controls about 400,000 acres, about half of which is irrigable.

The Alberta Land Company, operating as a subsidiary company to the last-named company, and diverting water through its works, has a grant of 500 c.f.s. from the Bow River at high-water and flood stages. The works of this company are not yet completed.

In the province of Saskatchewan irrigation has not been undertaken to nearly the same extent as in the province of Alberta, and it has no large irrigation companies. There has been granted to date in Saskatchewan, for irrigation purposes, 423 cubic feet of water per second, and this quantity is divided among 241 individual users. This gives each one an acre of 1.75 cubic feet per second, or enough to irrigate 262 acres.

Licenses are granted by the Dominion Government, under the administration of the Minister of the Interior, for the use of water, under the following classification:—

1. Domestic uses.
2. Industrial uses.
3. Irrigation purposes.
4. Other purposes.

The procedure followed in granting water-rights is, briefly, as follows:—

Any applicant for a water-right must first submit a memorial setting forth the purposes for which the water is required, and, accompanying this, must be general and detail plans showing where, and how, and for what purpose, he intends to use the water and what works he intends to construct or install. The next step is an inspection of the scheme by one of the government engineers, who reports upon the feasibility of the scheme, the question of water-supply and the character of the works to be constructed. The proposed scheme is then advertised in a local paper for six weeks, in order to give the local public notice of what is proposed and what water-supply and lands will be affected. Any protests which may be made against the proposed scheme are carefully investigated. Authorization is then issued for the construction of the necessary works, and a limit of time is placed within which the construction must be completed. The Department's engineers inspect all schemes periodically during construction, and, finally, after the works have been satisfactorily completed and inspected, the water license is granted.

The work of inspection is divided into two districts, within which the bulk of the work lies, viz.: the Maple Creek district and the Calgary district; the other schemes, which are widely scattered, are inspected by so-called special inspectors.

The Maple Creek district is under the especial charge of a division engineer, who has under his control two assistant engineers, each with a field party working under his direction. The Calgary district is patrolled by one district engineer with a small party.

Determination of the Low, High and Flood Discharge of Streams.—In order that the following may be intelligible it is necessary to explain the procedure in granting water-rights against any stream or other source of supply. The procedure is to consider that every stream has three separate stages of flow; that is to say, low-water stage, high-water stage and flood stage, and each water-license is issued against a specified stage of the stream flow.

In order that, under average conditions, there may always be enough water in the stream to fulfil the obligations of all the licenses issued, it is clear that the records of this office must show definitely the quantity of water in the stream, under such average conditions, at the three stages above mentioned. It is also clear that it is a most difficult matter to determine accurately the flow of the stream at the three respective stages: in fact, these figures can only be determined with even a fair degree of accuracy after a long series of stream measurements has been carried on on each stream. It is at this point that the work of stream measurements is indivisible from the work of irrigation inspections.

At the present time the quantities for all the streams, shown against the stages of low, high and flood discharge, are most inaccurate, as they, indeed, must be, because at the time when they were computed several years ago practically no continued series of stream measurements had been made.

During the present winter the matter of determining these quantities with some degree of accuracy is being actively taken up. The Department now has fairly complete records of stream-flow on several streams from the year 1908 to the year 1911, inclusive, and on most of the important streams used for irrigation purposes the records of stream measurement date back to 1909. The procedure being adopted is as follows: A separate sheet is being prepared for each stream, and on this is being plotted as a profile the mean monthly discharges for all the years during which records have been obtained. The profile for each year is plotted with a different colored ink, so that the different years can be readily distinguished. After a careful study of each sheet two horizontal lines are drawn across the profiles showing the three stages of flow as arbitrarily determined from the study. The horizontal lines are drawn only in pencil, so that at some future time, when more records of stream-flow are available, they may be shifted if necessary to more accurate positions as shown by the increased length of the period over which the stream measurements have been gained.

This arbitrary determination of the stage of the streams is a most important matter, as, if these determinations are in error, the streams will either be over-recorded or under-recorded. In the first case, the existing rights of the first license will be jeopardized, and, in the second case, applications will be refused when sufficient water is really available and might be put to beneficial use for irrigation or other purposes.

The rivers must be regulated for all beneficial purposes in order to develop their maximum potentiality; so should the regulation of all the beneficial purposes be carried out

by one department so that in studying any scheme of conservation every beneficial use may be given due consideration. Forestry, irrigation and drainage are at present in one branch of this department, under the Director of Forestry, but the investigation and regulation of power production is a separate branch. It is most important that this work should be included in the work of the irrigation office, or at least placed under the direction of the same head, the Director of Forestry. The water-power branch has its headquarters at Ottawa, far removed from the scene of its work, and it has no organization in the West with which to carry out the necessary investigation. The irrigation office, on the other hand, has its headquarters at Calgary, and has a well-organized establishment and a staff of engineers familiar with western conditions. In concluding this topic the case of the Bow River is most illustrative. The government anticipates reservoiring the waters of this river, and in doing so it must consider the claims of irrigation, and also of power production. The claims of these two industries are antagonistic, in that irrigation requires the stored waters for use in the summer and power production requires the stored waters for use in the winter. The two demands have to be adjusted and balanced, and it would be waste of space to further explain that this question can far better be studied and adjusted within the confines of one branch of the department than by two separate branches, neither of them responsible to the other.

The people in the United States have, after long years of bitter experience, come to the concrulsion that these matters are indivisible. Cannot we save all the inevitable blunders and heart-burnings of the future by profiting by their experiences and having this matter adjusted at once?

GOOD ROADS IN ONTARIO.

Last month the Ontario Good Roads Association held its annual meeting in Toronto. On that occasion W. A. McLean, Chief Engineer of Highways for Ontario, gave an address before the Association, an abstract of which we are now pleased to present to our readers.

The roadways constructed under the county road plan last year, aggregating 240 miles, and if placed in a continuous line, would extend from the city of Toronto to Ottawa, a fairly good stretch of highway. If we keep improving in the future as in the past, the prospects are very favorable for a good system of highways throughout Ontario. During the past few years, the cost of highway construction in Ontario has greatly increased. Highway construction is not made up of the cost of material in the pit, or stone in the quarries, nor by the cost of machinery, but rather by the cost of grading and drainage, of operating machinery, of getting material out of the pit and out of the quarry, crushing and preparing it for the roads and putting it in place. That means that the principal cost of road construction goes into wages of men and teams. Ten years ago, the cost of labor was $1.25 for men, and teams could be had for $3.50 per day. I have seen, this year, instances of men being paid $3 a day, and teams $6 a day, with a fair average over Ontario of $2.50 per day for men and $4.50 and $5 for teams, which means that the cost of road construction is practically twice as much to-day as it was ten years ago.

To meet the situation, we shall have to dispense, as far as possible, with horses and manual labor, and turn our attention to road building through the use of machinery. But, to build roads with economy by the use of machinery, we must keep the machinery steadily employed. We must stop the annual patching of roads by men and teams, and expand the county road plan; not to build roads in short, scattered sections, but rather in long stretches.

Road Drainage.—Last season one of the striking features of the year was the heavy rainfall, and from all sides we heard that the roads were badly worn. Where our road went to pieces, under the influence of last season's heavy rainfall, it means largely, a lack of drainage; that sufficient precaution had not been taken to put a proper crown on the road, open ditches, and put in culverts where they ought to be. We have got to drain in Ontario, not for the ordinary summer weather, but for the heavy rainfalls which come periodically; and for the Spring time.

We have a standard type of roadway in Ontario. The width between the shoulders is 24 ft., the crown depending upon the width of stone, and varying from half-an-inch to an inch per foot between the shoulder and the top of the road. Below the shoulders, there should be 18 inches or two feet of drainage. The stone in the centre should depend upon the traffic over the road, ranging from 8 to 16 feet wide.

Everybody wants good roads, but few want to pay for them. They do not want to pay for them with half the zeal with which they ask for them. It is extremely important in entering upon any scheme of construction to have an equitable system of distributing the cost. The people of this country will not object to pay a reasonable price for good roads if the cost is equitably placed upon those who should pay for them. My experience is that, while the people at the commencement are often opposed to good roads, when they begin to see results, they say "That is the road we want, and will pay what it should cost."

The increase in the price of property along highways which have been recently constructed, indicates the real service good roads are to a country. We talk about the service good roads do socially, commercially and otherwise; but getting to practical dollars and cents, we find that property along a good road is increased to the extent of $500 to $2,000 for each one hundred acre farm. Increase in the value of property is a pretty good indication of the service these roads are to the people of the country. Just think what that means. Every one hundred acre farm is increased in value to the extent of $500 to $2,000. With eight farms fronting on each mile of highway, it means an increase of from $4,000 to $16,000 per mile of road. With that increase, property can pretty fairly be assessed for the cost of a great portion of the roads. When you take from that cost the proportion the province is paying under the Highway Improvement Act, it looks like a pretty good proposal for any part of the country to construct good roads.

In proposing the construction of a main highway between Toronto and Hamilton, the people along that highway said, "If you will construct it, we will pay an annual frontage tax of one and a half cents per foot for thirty years." The people on that highway have consented to the plan, and it indicates that the principle, if extended and made applicable to certain other of the most important highways, could be serviceable and acceptable, and would help to create the fund necessary to construct good roads.

It is also argued, and very properly so, that the automobile should be specially taxed. I will not go into the question of the destruction of the roads from the use of automobiles. They unquestionably do considerable injury to the highways, especially heavy cars which travel at high speed over stone roads. But it is a notable fact that the automobile owners have consented to pay such a tax; which will no doubt be imposed.

Now the population of the towns and their assessment throughout Ontario is practically equal to the population and assessment of the townships; therefore, I take it that the people of the towns and cities are paying one-half of that one-third, or one-sixth of the cost of the good roads con-

structed under the Highway Act at the present time. One-sixth, I think you will agree with me, is not sufficient.

The Highway Improvement Act has been before the people of Ontario for some time. For over ten years, counties have been offered one-third of the cost of constructing main roads, and all of them have not yet jumped at the chance. I do not know just why they have not.

The Highway Act is extremely simple in its operation. The county is empowered to take over and maintain the main roads of the county highways used by the people of that county, and serving the market requirements of the people of the county. They appoint their own superintendent or engineer to direct construction for the county council. At the end of the season they send us their statement of expenditure and we pay them one-third of it. Up to the present time we have not had any serious trouble with any county. Sometimes they say we are a little slow, but we get there just the same, and they always feet sure of their cheque. The county council controls these main highways in the same way as a township council would manage their roads. By concentrating our efforts and energies on a special system of highways we follow a principle that is absolutely essential in any similar form of organization. In any line of construction you must concentrate sufficient energy on a fixed object to accomplish that object; to complete it and then go on to the next.

I have referred to organization. Organization, I am convinced, is the key-stone of the situation. If you get your organization as it should be, everything else will take care of itself. The superintendent should practically take the place, with county council, of a contractor. He should be the type of man who would be a successful contractor.

Another important part of the organization is the foremen. Part of the qualification of the superintendent should be that he is able to select and get to work for him, and with him, good and capable foremen. What is a foreman? The word "foreman" explains itself. It means the first man: the head man on the work, carrying out the instructions which have been given to him, and whose special duty it is to get the men, the teams and machinery to give fair and honest service on the road. Between the superintendent and the foremen, you have the essential features of an organization, and too much car cannot be taken in the selection of these men.

It is part of the duty of the superintendent to plan his work, and every foreman should be the first man on the job, with the day's operations well planned. Not only should the superintendent plan for carrying out the construction, but the foreman should come to his work each day with a clear understanding of what he is going to do. These are some of the features of the organization that we should try to build up.

Contract vs. Day Labor.—I am sometimes asked if it would not be well to construct roads by contract instead of under the county road superintendent and his foremen. In road construction, in my experience, in order to get as good results from a contractor as from your own foreman, you must spend too much on surveys and engineering supervision to get the contractor to carry out the work. Specifications must be so complete that they frighten the contractor and increase the amount of his tender. The contractor's risk is also greater than that of the municipality. I have seen sections where contract work had been carried out very close to day work, and going over those two sections, we could point out the parts which had been built under the county superintendent and those under the contractor. The time is approaching when, I believe, we can construct highways by contract, but for the simpler class of work, the best and cheaper results will come through carrying out the work under the superintendent and foreman. When we come to make provincial highways, such as are constructed as state highways, I can understand where the plant of the contractors can achieve excellent results, and his organization can be made of good use. But, up to that stage, I believe that the best and cheapest results can be obtained by doing the work under your own superintendent.

Freight Rates on Stone.—It is important to get stone, in a great many parts of Ontario, as cheaply as possible. There are parts of the province where there is plenty of stone. where the people would like to exchange it for some of the good soil of Essex County and Elgin. Down in Leeds and Frontenac there are points where they have so much stone that they do not go off the highway to procure it. But in certain parts of Ontario the only way we can build roads is to ship stone by rail. That is expensive; and there has been a feeling among the counties that the freight rates ought to be reduced. I believe so too, and we have placed the matter before the railway corporations from time to time. The last negotiations entered upon were the most hopeful I have yet undertaken, and I hope we may be able to get the freight rates on stone reduced. But we cannot control two ends of the string at the same time. The point has been raised that if we get the freight rates reduced, we are merely creating an opportunity for the quarry owners to increase their price for stone. If we can in any way get the cost of hauling the stone reduced, we shall expect to look after the other end of the problem.

It is the fact that in every township, if you have not good main roads at the present time, as soon as a good road is constructed, it becomes a main highway, it draws the heavier traffic from other roads. From this cause, townships can construct an inferior type of highway for branches from the main road, which will serve equally as well the traffic over them. My view is that every road in Ontario, travelled to any extent, should receive a due degree of care, and by proper organization in our townships, this can be done.

To get a system established in the townships, there are some essential steps. One is that you place your system on a cash basis. Collect what you require as a special levy on the assessment of the township, what your people can afford. When that sum is a sufficient amount, say $3,000 or $4,000, you should have a foreman appointed under the township council to take charge of the expenditure. By starting early in the year, he can, with the grading machine, grade the roads at the time of the year when earth is in a suitable state to be handled. We often see grading in progress on clay roads when they are as hard as bricks. That is a mistake. Road construction should go on at the time of year that is most suitable. The foreman should be out early in the Spring as soon as the soil is fit, to do all the grading that is required for the year. By using the log-drag on the roads after grading, for maintenance you do not have to repeat the grading operation and it becomes permanent. But the log-drag is useful only as you make it part of a system, and the organization of that system ought to be the duty of the township foreman. After the grading of the year is done, when the streams are low and the ditches dry, that is the time for him to build the small bridges and culverts. Gravelling, if there is gravel in the township, can be let by contract, and carried in when the grading is finished. In the fall, drainage should be completed. By employing a permanent foreman you create in him an experienced employee who will be able to bring that skill to play upon your highways such as other countries have found necessary.

On page 440 of last week's issue, in connection with the report of the Canadian Society of Civil Engineers, Mr. V. J. Elmont's name appeared as Mr. Almonte. The mistake was made as a result of the compositor following the copy as supplied by the verbatim report of the discussion.

STEEL FORMS FOR CONCRETE CONSTRUCTION.

The application of steel forms to conduits, culverts and drains is dealt with in the following article by William Mayo Venable. From his experience of many years on reinforced concrete sewage and drainage systems he is well qualified to write on this subject. In "The Cement World" of January, 1913, dealing with the use of steel forms as above, he writes:—

From the very earliest days of concrete construction until the present, the use of steel for building forms has been constantly increasing in favor. In the earlier days steel was resorted to occasionally by individual contractors who designed and built their own equipment to meet particular conditions, or by builders experimenting to ascertain some more economical method of providing for their centering.

The use of corrugated steel, either plain or galvanized, to support floor loads, both as temporary centering and to be left in place permanently, represented one of the earlier attempts to employ steel for concrete construction. This particular material, corrugated steel sheets, has continued in use for the same purpose, but has found a much wider field of recent years as lagging to support concrete floors of flat slab construction in those cases where the appearance of the corrugations on the ceiling is not considered objectionable. This is probably the most conspicuous instance of an early type of steel centre which has come into common use. The low price of corrugated steel and the ease with which it may be placed and moved on work of this kind without appreciable damage makes it the material which appeals to building contractors generally.

The application of steel in the construction of forms for engineering work generally, however, has been brought about largely through the efforts of a few concerns that are specializing in this line. The reasons for this are that the fabrication of steel cannot conveniently be carried on by individual contractors with the facilities which they possess, and that contractors generally are not usually sufficiently familiar with the requirements of steel form designing to be able to design their own forms and have them built for them. Aside from the fact that there are certain fundamental patents on steel forms, there is another reason which likewise has operated to cause the steel form business to be developed as a separate industry, and that is the very great advantage that accrues to the user of the form by being able to lease apparatus suitable for this work, instead of being obliged to pay the full price of having the forms made for his particular job.

Steel forms are in more extensive use in the construction of sewers, drains, conduits, tunnels and such engineering works than in any other kind of construction. Works of this kind possess certain characteristics that are not common to other types of work upon which concrete is extensively employed. They extend from considerable distances without change of section, and they are always, in whole or in part, composed of curved surfaces. A form to construct a sewer or an aqueduct must be designed so that it can be used over and over again very many times. It is not at all uncommon for a form to be used as many as 30 times over in the construction of a single sewer, while in building construction it is unusual for a form to be used over more than 3 or 4 times on one building. Thus, it is readily seen that the form for a conduit should be made much more durable than is necessary for a form which is not expected to be re-used more than a very few times. The use of steel for forms for conduit of all kinds provides a form which is not injured at all by depositing the concrete, but which will retain its shape indefinitely. This, however, is but one advantage of the use of steel on such work. In conduits of all kinds it is necessary to economize space in order that there may be room for the workmen inside of the conduit and also room for shifting the forms themselves. Wooden centres, in order to secure the necessary strength, occupy so much room with their bracing and other frame-work that it is very nearly impossible to arrange to shift them with the necessary degree of economy.

In conduit work there are two different methods by which the work may be carried on so far as the forms are concerned. Forms for one section may be set up, concrete deposited about them, and the forms then removed and carried forward for another section, the process being repeated thus until the entire structure is finished. If the work is carried on in this way it is not necessary to pull one set of forms through the conduit which is occupied by another set. The other method of conducting the work is to provide the forms for a given length of conduit and constantly to convey the forms from the portion of the conduit which is completed through the portion of the conduit which is being constructed, and to set them up in front, where the conduit is to be extended. It may readily be seen that with wooden forms the first of these methods implies taking the forms apart into many pieces, carrying these out of the ditch and assembling them again in a new position; while the second method implies taking the wooden forms apart in panels and conveying these panels forward through the bracing which supports the panels upon which the concrete is being placed. These are both extremely laborious and expensive processes with wood. With the use of steel forms they are rendered extremely easy.

On conduits of moderate size, where the depth of the excavation is not very great, it is usually found more economical to shift the forms from one position to another without conveying them through forms already set up. Steel forms when used in this way are provided with a carrier of some kind, usually a series of small wheels attached to the sides of the form, by which they may be conveyed forward without being taken apart at all. Thus 100', or over 200' of centering for a sewer may be moved at one time, it merely being loosened from the concrete by means of turnbuckles, lowered upon wheels and pulled out with a line to the new position in which it is raised to the proper height and braced to the proper width. This is called pulling the forms "en train."

Where a section is circular the same form may be used to form the invert as is subsequently used to form the arch, but usually the form for the invert is kept separate from that for the arch, the invert being built first and the arch built subsequently. In circular conduits a centre for either invert or arch consists of plates bent to a little more than half a circle, stiffened by angle-irons running longitudinally, joined together at intervals by simple fasteners so as to form a continuous trough, and placed in such a position that it may be collapsed or stiffened, if necessary, by means of turnbuckles.

A circular section is by no means adopted for most of the larger sewers or drains. In some of these structures the bottom, or invert, is made with sides having only sufficient inclination to keep them free from deposit when the conduit is in use. The side walls are often perpendicular for some little distance, and the arch semi-circular. This form of conduit can be built in three operations, viz., the invert, the side walls, and the arch; or may be built in two operations, consisting of invert and portion of side walls, and the balance of the side walls and the arch together. Modifications of this design are very common, in some cases the side walls being slightly curved. Egg-shaped and flattened elliptical conduits are often required, and these, as well as the circular, lend themselves to the use of steel in their construction. It

is, of course, obvious, however, that the circular and semi-circular sections, being in such common demand, can usually be constructed much more cheaply than other sections, because forms for them can be used on many different contracts in succession throughout the country. Engineers are generally well aware of this fact, and take advantage of it in making their designs. There is scarcely an important sewer system which has been constructed in this country in recent years upon which the half-round collapsible centre has not been used to a considerable extent.

Generally speaking, it is more economical for the contractor to build a sewer in two sections, the invert first and the arch subsequently, no matter what the cross-section of the sewer may be, than it is for him to pour the entire structure in one operation. It is also generally preferred by engineers that the invert shall be constructed and the forms removed for inspection before any work is done on the arch, and where sewers are reinforced with steel, the splice of the steel is generally made about the springing line of the invert. By dividing the work in this way the engineer is able to inspect the most important part of it, the invert, which carries the actual flow of water, without having to enter the finished conduit. It is also often preferred that the men should work in daylight rather than by artificial light to do any work requiring close inspection. There are, however, numerous occasions upon which it is considered essential that the structure shall be poured as a monolith, and in such cases it is necessary to build the form so as to make a complete circle, which may still be collapsed and removed conveniently, care being taken that the joints are so made that one or the other of the sections may be removed first. If the design is not very carefully worked out with this object in view, a full round centre is likely to bind, and become extremely difficult to shift.

Half-round centres to be pulled "en train" have been made and used of all diameters, from 2′ up to 25′. Usually however, the length of time that a centre must be left in place on a conduit of the larger size, and the necessity of arranging the work so that the concrete can be deposited every day, render it necessary on large work to design the centres so that they may be collapsed and pulled through one another. Just when it will be more economical to pull a centre "en train," and when it will be more economical to collapse it and carry it forward in sections ought to be determined in connection with each particular construction after careful consideration of the local conditions, the depth of the excavation, the arrangements for depositing concrete and the liability of the work to interruption or injury on account of having a greater or less amount of open ditch at one time. Wherever it is practicable to stretch out the work over a long distance without incurring any liability to damage, there will be a certain advantage in arranging the work in several sections and pulling the forms "en train," rather than in collapsing them and carrying them through one another; but on the largest work it is very seldom practicable to spread the work out in this way, and usually where the conduit is more than 8′ or 10′ in diameter more economy will be secured by building the centre in sections and collapsing one or two or three sections at a time and conveying them forward through the assembled sections of form to the new position.

On the large concrete sewers, aqueducts and drains built in recent years, it has been almost universal with contractors to collapse the centres sufficiently to convey them through other centres which are supporting concrete which has not yet set sufficiently to permit the centres to be moved. The best example of this method of working is found on the new Catskill aqueduct which supplies the city of New York with water. This aqueduct is 90 miles long. Throughout most of this length water is conveyed in a horseshoe conduit 17′ 6″ wide and 17′ high, built at a grade which permits the water to flow without completely filling the aqueduct. Other parts of the work are in tunnel, or on viaducts; while that portion of the work which enters the city of New York is in many places at a great depth from the surface of the ground. Practically all of this concrete has been cast on steel forms.

Where the work is conducted in open cut, these forms are collapsed and supported upon carriers in the finished aqueduct, and they are conveyed through the portion of the work which is yet under construction and expanded into position in front. The same method of handling the forms has been employed on the new sewerage systems at Louisville, Baltimore and East St. Louis.

Very large forms adapted to collapse and move forward in large units have been used on the locks of the Panama Canal and for the pressure tunnel of the Ontario Power Co.

In tunnel work, it is sometimes possible to utilize forms that collapse and pull through in units similar to those used in sewer work, but very frequently on account of the difficulty of getting concrete into place in tunnel work, it is necessary to carry on this work with a series of panels which are attached to ribs as the concrete is deposited. This method is extensively employed in tunnel work for railways and while not nearly so easy to handle as the form that can be moved in large units, it has proved to be eminently practical and economical in work of this class.

In all such work it is customary to build the forms especially to fit the design of the particular structure in view, and not to attempt to consider the form problem at all in the design of the concrete structure. Wherever the length of the conduit is sufficient, this is the most economical practice, but where the lengths of the conduit is not great it will be found more economical to use circular or modified circular forms upon which a standard steel form can be used,—a form which can be leased for the moderate rental—than to adopt a peculiar shape which will require a form built to order, and consequently an unnecessarily heavy expenditure for the form work. It should be remembered that where forms are made of wood to meet any particular conditions, they cost 12c. to 16c. per sq. ft. of form surface, and that if the walls of the concrete structure be thin, this amounts to over \$5.00 to \$10.00 per cu. yd. of concrete in place. In fact, the cost of forms on very many concrete structures exceeds the sum of all other costs entering into the concrete. The saving that may be made by adopting sections which will lower the cost of the forms is so great that every engineer should consider it in making his designs, more especially upon those parts of the system he is designing which are too short to justify the manufacture of special apparatus for constructing them.

The cost of a system of concrete storm sewers may very easily be reduced by 15 per cent. or 20 per cent. of what it might otherwise be by having careful consideration given to the cost of the form work, and so laying out the system before construction is commenced as to secure the greatest economy in this item.

All collapsing and conveying methods used on forms similar to those described for circular and horse-shoe shaped conduits are adapted to rectangular or box-shaped culverts such as are commonly employed in flat lands where it is necessary to build drains of large capacity without deep excavation. Box-shaped forms for drains with flat slab covers should be designed so that the same forms can be used on the various sizes of drains in any common drainage system, beginning with the largest on the main line of the system and extending to the smallest laterals. Forms of this kind are readily made in such a manner as to permit the removal of panels of various width so as to change the width and height of the conduit wherever necessary.

HIGH-SPEED BEARINGS.*

By John C. K. Balfry.

When considered in connection with the subject of this paper, the term "high speed of revolution" is somewhat misleading, for one should speak of the speed of journal surface rather than of speed of revolution. For example, take the case of a De Laval steam turbine having a shaft 10 mm. diameter revolving at 30,000 revolutions per minute, and compare the surface velocity of it with that of a steam turbine shaft of 100 mm. diameter revolving at 3,000 revolutions per minute. The surface velocity of each is about 51.6 feet per second, but the speed of revolution of the first is ten times that of the second.

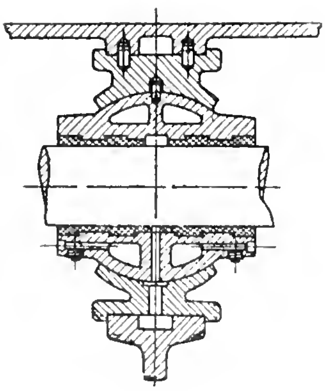


Fig. 1.

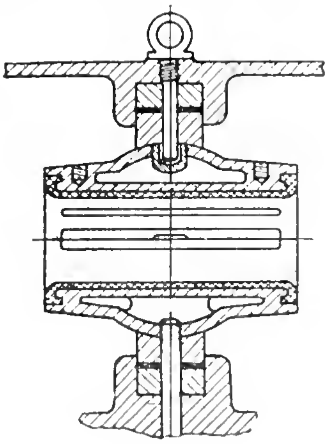


Fig. 2.

With rotary machines of the turbine or electrical kind, it may be considered that surface speeds of 50 feet per second are quite ordinary, and 100 feet per second as high. Pressures, per unit area of projected bearing surface, in common use with the kinds of bearings under consideration are small when compared with those met with in, e.g., modern railway practice, where 300 lb. per sq. in. of projected bearing surface is not at all exceptional in the case of driving axle journals; but the conditions under which these work are very different. Briefly, 50 lb. per sq. in. of projected bearing surface may be considered ordinary, and 90 lb. per sq. in. high for bearings of the class being dealt with.

Steam Turbine Bearings.—These may be grouped under three heads: (1) Rigid bearings; (2) swivel bearings; (3) concentric ring bearings.

1. By a rigid bearing is meant one wherein the shell is held rigidly in the housing or pedestal surrounding it. It is adaptable where shaft deflection is very small, the slight slackness or clearance between the journal and the bearing, and also the presence of a film of oil around the journal, being taken advantage of. Obviously, these bearings are of use only where journal centres are comparatively small.

2. The swivel bearing is no doubt the most widely used kind in turbine practice to-day. Its name indicates one of its outstanding features. It is adaptable practically to all kinds of turbines and generators. It allows itself to radiate in the housing about its centre, thus accommodating itself to the deflection of the shaft, so that its use with shafts having great length between journal centres is almost universal. It is easy to design the shell in such a way that lateral and vertical movement, required for alignment when bearings are being set at a considerable distance apart, is readily attained.

3. The concentric ring bearing has characteristics which are set forth in the description of it which appears further on.

The shell of the "rigid" type of bearing is usually made of good, close-grained cast iron, and is lined on the inside with white metal; babbitt, delta, or magnolia metals are found suitable for this purpose. It is turned on the outside of the shell to fit the pedestal, in which it is prevented from rotating by means of dowels engaging in holes in the cap or cover of the housing; a flange at each end prevents end movement. There are, of course, other methods of preventing rotation and end movement, but the above is perhaps the simplest. If it is found necessary to water-cool such a bearing, the problem is much simpler than that which presents itself when the same treatment is desired for a bearing of the swivel type.

A bearing of the rigid type is fitted to a 2,000 kw. steam turbine of the A.E.G. type. In this instance the shell is made of brass, and is lined with white metal. Among the interesting features it possesses may be mentioned that the oil, before being admitted to the journal, is passed around the space between the housing and the shell to render the oil thinner before use. This appears to have a double effect on improving conditions of working—the shell is cooled by the circulating oil, and the friction losses in the bearing are reduced by the higher oil temperature. The surface speed of the journal is said to be 96 ft. per second.

The Swivel type is illustrated in Figs. 1, 2, 3, 4 and 5. Fig. 1 is used with a Melms Pfenninger steam turbine of 3,000 h.p. at 1,500 revolutions per minute. It is 180 mm. diameter by 380 mm. long, and the journal surface speed is 46 ft. per second. The shell, which is made in halves, is of cast iron, and is lined with white metal. The temperature of the bearing can be kept below the danger point by circulating water through the chamber shown. A cage is provided giving ample bearing surface for the shell. The housing is, of course, on the outside, the cage being provided with lugs to prevent end movement. Dowels prevent cage and bearing from rotating. Oil is fed under pressure into the annular space in the housing, through a hole in the bottom of both cage and shell, into a partly annular space around the journal.

Fig. 3.

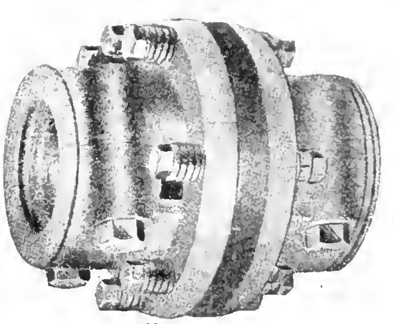


Fig. 4.

Fig. 2 illustrates a bearing used with a 1,500 kw. 1,500 revolutions per minute steam turbine made by the Brush Electrical Engineering Company. The shell is hollow, and is lined with white metal. The diameter of journal is 5 in., and length 15 in. The bearing is capable of being easily aligned both vertically and laterally, shinplates being provided between the cage, which is immediately without the shell, and radial pads which are screwed to the cage. Both shell and cage are made in halves, and both are prevented from rotation in

* Paper read before the Rugby Engineering Society.

the manner shown, end movement being prevented by the flanges forming part of the housing. It is interesting to note that the oil, before being admitted to the journal, is passed through the hollow shell. Grooves arranged longitudinally, and well chamfered on their edges, are provided in the top half of the bearing surfaced. The surface velocity is about 33 ft. per second.

The kind fitted to a Zoelly steam turbine of 200 h.p. at 3,000 revolutions per minute is of cast iron, lined with white metal. Lubrication is effected by six rings arranged in two chambers containing three rings each. The bearing is water-cooled, water being supplied to and returned from the hollow shell through two unions screwed into the top half of the shell; these are not illustrated. The ringed shaft is provided for expansion purposes, and keeps the shell and shaft always together. This bearing is 60 mm. in diameter by 250 mm. long, the surface speed being 31 ft. per second. Oil, after being carried to the upper surface of the journal by means of the rings, is distributed to the surfaces along grooves in the white mdetal. These grooves or channels "take in" at the top on both sides of the ring chambers and spread away spirally, returning again to the chamber farther round the shaft. By this means an effective method of lubrication is obtained.

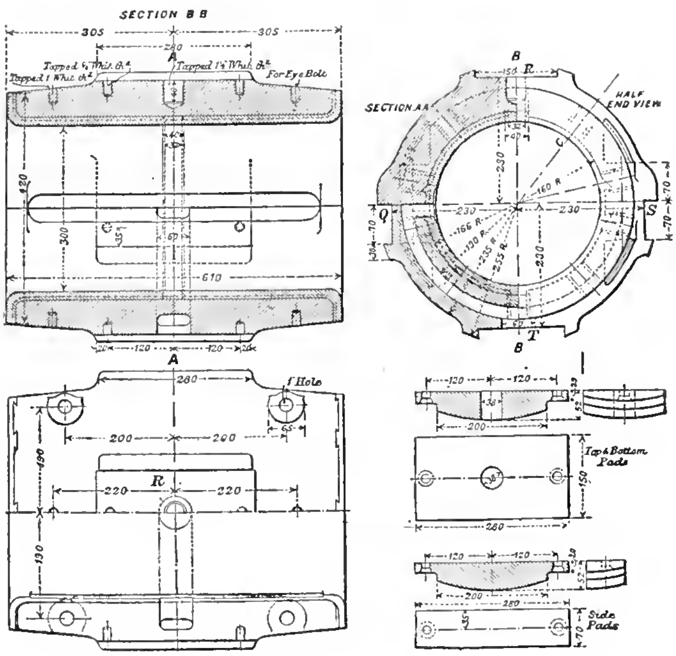


Fig. 5.

Fig. 3 is an illustration of a bearing fitted to steam turbines made by the British Thomson-Houston Company, Limited. It possesses several interesting features, among them being its "clean" finish and simple design. It consists of a cast-iron shell lined with babbitt metal; the shell has spherical seats, and the bearing is made in halves. Oil is delivered into a groove in the white metal and along the horizontal centre line, and is drawn down by the rotating shaft. On the side opposite to the oil inlet a second groove is provided, but it differs from the groove on the inlet side in being open at its ends thus allowing oil that has passed under the shaft and has become heated to pass easily away at the ends of the bearing. Lubrication and cooling of the upper surface of the journal is effected by means of grooves leading from the inlet groove diagonally.

Fig. 4 shows a bearing which has important characteristics. It is fitted to generator shafts at the exciting end of the rotor. When a turbo-generator is passing through a critical speed there is a tendency for the shaft to "whip." In order to destroy this action anl ensure that the shaft will pass through a critical speed with absolute safety, the bearing sleeve is permitted a small amount of radial play between friction collars. This bearing, it will be noticed, is made in halves, and the radial sideplates or collars are bolted in an elastic manner to the shell. It is made by the British Thomson-Houston Company, Limited.

A bearing such as is fitted to turbines of 7,000 kw. capacity when running at 750 revolutions per minute is illustrated, together with its accessories, in Fig. 5. It consists of a cast-iron shell to which is secured at four positions the pads which allow the bearing to swivel about its centre. The swivel pads are shown in the right-hand bottom corner. It will be seen that the shell is made in halves, secured by comparatively small bolts and nuts. The interior is lined with white metal cast by the "Eatonia" process. The oil is conducted from the bottom of the shell along the two oil-ways shown up to the horizontal centre line; there it feeds the two wide channels arranged on each side of the bearing. These channels are well bevelled at their sides, and extend almost the whole length of the lining, and have a sealing piece at each end. These bearings represent a design which Messrs. Willans and Robinson, Limited, have used on both large and small steam turbines.

The Parsons concentric-ring bearing consists of a gun-metal sleeve in which runs the journal. The sleeve is surrounded by two or more gun-metal rings arranged in sets, and separated by an oil or lantern ring. The whole is mounted within a heavy cast-iron outer sleeve, to which the innermost sleeve is lightly secured at one end. This outer sleeve is spigoted to the housing only, and not to the cap, by means of a loose cast-iron half-ring which fits in the groove stem at the bottom.

If it is desired to remove the bearing, the cap is first removed, and the half-ring rotated until it is free of the pedestal and bearing. It is then possible to slide the bearing endways off the shaft. There is a clearance of a few thousandths of an inch between the rings and sleeves. Oil finds its way into these spaces, tnd thus there is a hydraulic cushion which dampens those vibrations which are inseparable from shafts having speeds of rotation.

COAST TO COAST.

Toronto, Ont.—At a meeting of the Hydro-Electric Power Commission held recently an important change in policy was decided. Hereafter the Commission will not acquire easements for right-of-way but will expropriate the necessary strip, 66 feet wide, required for transmission lines. This departure will apply to the extension of the Niagara transmission line from St. Thomas to Windsor as well as other contemplated extensions in the Midlands district and in eastern Ontario.

Montreal, Que.—In the course of the work of the Mount Royal tunnel many interesting speciments of rock have been met with and definite proof of the volcanic origin of Montreal's mountain obtained. The indications, according to the engineers, show that the mountain was at one time either an active volcano or that lava forced its way up a central orifice, bursting and breaking the summit of the mountain, but possibly never actually spouting forth as an eruption. Numerous fossils have been found and also a particularly fine specimen of crystallized calcite. Copper and iron pyrites are also evident in some of the rock.

Montreal, Que.—The experts working on street car congestion of this city have prepared their report for the Mont-

real Tramways Company. These plans cover a gradual development designed to be spread over the next couple of years, and eventually the development will care for the population for the next ten or twenty years.

It is stated if the proposals of street extensions, etc., are carried out, the company will find it necessary to order 2 o cars in addition to the 200 now on order. The total expenditure will amount to from $8,000,000 to $10,000,000, which the company is fully prepared to make.

Providence, R.I.—The Narragansett, the first of the Grand Trunk boats for Atlantic coastwise trade, from the shops of Harlan and Hollingsworth, Wilmington, Del., has been launched recently. The Manhattan, a sister ship, will be launched later. Both have been designed by Mr. Kirby, of New York and Detroit, a well-known marine architect, who has designed some of the largest steamers on the Great Lakes. These vessels have been built for the Central Vermont Transportation Co., and were financed a year ago by the sale of $1,500,000 bonds. The Narragansett is of steel, and has a capacity for 700 passengers and 500 tons of express freight. The Narragansett and Manhattan will ply between Providence and New York.

Sarnia, Ont.—Wireless machinery is being installed in the wireless station at Point Edward by the Canadian Marconi Company, which will be in charge of the station and will operate it for the government on a percentage basis. The apparatus consists of two sets of dynamos connected engines, so that if one machine with two eight-horsepower gasoline breaks down, the operator will have a second generator to fall back on. The sending radius of the machines will be 300 miles and will enable the station to work with the Soo on the west, or Ottawa on the east. The receiving machines will be able to take a message from any of the high tension stations on the continent as long as the sending station is strong enough to send out the waves this far. The station will be used by the government as well as for sending telegrams for the public. The charges will be considerably lower than those of wire lines.

British Columbia.—Work has been begun by the Northern Construction Company on the Lulu Island branch of the Canadian Northern Pacific Railway. The first camp has been established six miles below New Westminster and a second will be located a mile further west. The latter will undertake the construction of the two miles of trestling across the muskeg which exists here and for which two million feet of lumber will be required. According to Mr. J. M. Mercer, general manager of the construction company, this line will be completed by the end of May. The line from Port Mann to Yale is now nearing completion but it is not expected that a train service will be operated until about midsummer. All the stations from Port Mann to Yale have been named and the contract for their construction will be let in a few days. These stations will be Port Mann, Langley, Glen Valley, Mount Lehman, Matsqui, Sumas, Mountain, Chilliwack, Rosedale, Popkum, St. Elmo, Floodville, Hope, Trafalgar, Yale.

Washington, D.C.—The failure of Congress to enact legislation at the session just closed to extend the Burton Act which limits the amount of water diverted on the American side of Niagara Falls for power development to 15,600 feet, means that the Americans can increase the amount of water used for this purpose and that they may import more power generated on the Canadian side.

The treaty between the United States and Canada provides that 25,000 feet per second of water may be diverted for power purposes for each government. The Burton Act restriction, which was originally demanded by the American Civic Associations and other organizations, who feared unrestricted use of Niagara's waters would ruin the beauty of the Falls, has been extended twice.

Several American companies are preparing to import power from Canada and use the plants and machinery that have been idle since the enactment of the Burton law. Governor Sulzer states that in the absence of federal legislation the jurisdiction of the extra 4,450 feet of water permitted under the treaty with Canada, automatically passes to New York State.

Ottawa, Ont.—Mr. Clyde Leavitt, Chief Fire Inspector for the Railway Commission, and Forester for the Commission of Conservation, is now preparing a statement showing how the installation of the use of crude oil for generating locomotive power in stead of coal, may prove more advantageous to railways from a financial standpoint.

The Canadian Pacific Railway is now using oil-burning engines on its main line between Kamloops and Field, B.C. The Grand Trunk Pacific and some of the Canadian coast steamships also burn oil, while the new system is now in use on many of the railroads in the United States. The greatly decreased smoke, the decrease in the number of firemen required, the economy particularly in intermittent service, and the fact that three boilers heated by oil will give the same amount of steam as the same number heated by coal, all tend to make this new system popular.

The oil is obtained from the oil fields of California, and if future discoveries in Alberta and British Columbia make this oil more plentiful its use will be largely extended on Canadian railroads.

The use of this new fuel would greatly lessen the necessity for forest protection from flying sparks and cinders, and greatly decrease the loss experienced annually by the country from this cause.

Vernon, B.C.—This city recently opened a splendid new power house with a demonstration in which several hundred citizens participated.

The chief point of interest was the new Diesel oil engine which has just been installed, and the operation of which will enable the city to give the citizens the lowest lighting rate in British Columbia, and power rates unequalled by any city of its size in Western Canada.

The oil plant will be used continuously, the steam plant being used for auxiliary during the hours when the load is heaviest, until another 50 h.p. engine is installed and which the increased demand for power necessitates.

PERSONAL.

MR. F. N. NEWMAN, manager of The Canadian Fairbanks-Morse Co., Limited, of Toronto, is on a trip to England.

MR. F. J. ANDERSON, B.A.Sc., O.L.S., of the firm of Anderson and Berry, engineers, has been appointed city engineer of Niagara Falls, Ontario.

KESTER BARR has resigned his position with Manning, Maxwell and Moore, Inc., of New York, to take the position of manager of the Lumen Bearing Co., West Toronto, to succeed Mr. Fred Ganderton, resigned.

ARTHUR H. BLANCHARD, M.Can.Soc.C.E., Professor of Highway Engineering, Columbia University, has been appointed by Governor Sulzer a member of the Advisory Commission on Highways for the State of New York.

MR. H. M. MORROW, formerly assistant manager of the Asbestos Corporation of Canada is now in the employment of The Canadian Fairbanks-Morse Co., Limited, at Montreal, and will be associated with the motor truck department.

V. J. ELMONT, A.M. Can. Society C.E., read an interesting paper on "Trusses without Diagonals in Reinforced Concrete," before the Canadian Society of Civil Engineers on

the evening of March 6. Following the reading of the papers and the showing of a number of lantern slides, a discussion took place in which Prof. Mackay, J. A. Jamieson and others took part.

OBITUARY.

GEO. H. PEDLAR died suddenly at his home in Oshawa while preparing for a business trip to Chicago. Deceased was 70 years of age, and was president and manager of the Pedlar People, Limited, a company he established over 50 years ago, and which through his ability, became a flourishing concern, having at present offices in Toronto, Montreal, Ottawa, London, Chatham, Winnipeg, and Vancouver. He was throughout his busy life actively interested in public and social affairs and a generous giver to all charities.

SOCIETY NOTES.

At a meeting held March 14th, the following officers of the Engineering Society of the University of Toronto were elected: President, F. E. Mechin; 1st vice-president, F. S. Rutherford; 2nd vice-presidents, R. E. Laidlaw, K A. Jefferson, C. K. MacPherson.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase, Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto. Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O , Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, March 27, 1913 Contents of this issue on page 499

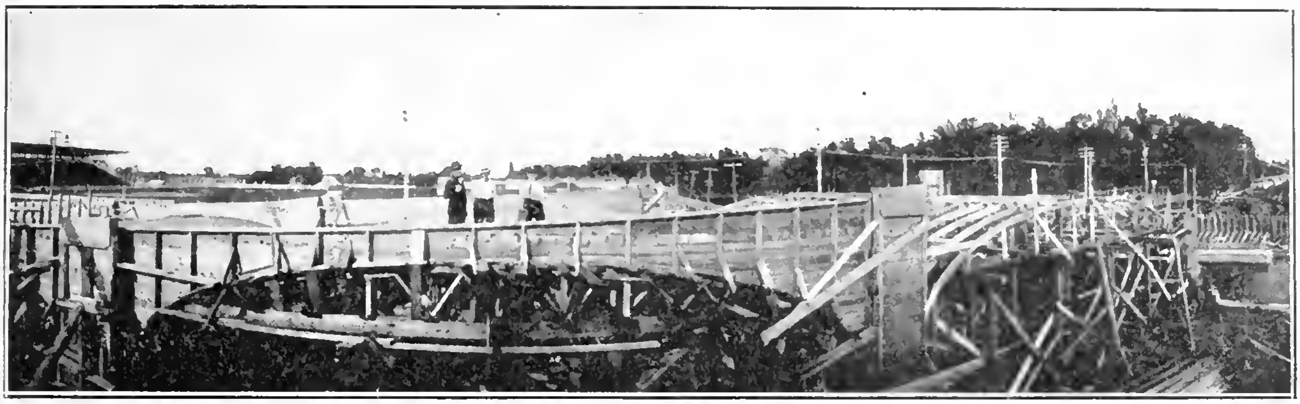
The Canadian Engineer

An Engineering Weekly

BANK STREET HIGH LEVEL BRIDGE, OTTAWA

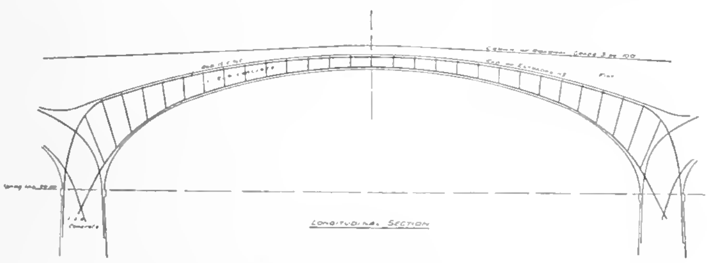
BY L. McLAREN HUNTER*

The Bank Street high level bridge, which is being constructed over the Rideau Canal by the city of Ottawa, is more than two-thirds completed. This new crossing will considerably help the development of Ottawa South, as it will enable the electric railway to cross the canal at this point. This they have been wanting to do for some time, as the traffic along Bank Street to Ottawa South is so very heavy; in fact, the heaviest in the city. The new bridge is badly required, as the old swing bridge was quite inadequate—to say nothing of the constant delay and congestion of traffic due to passing barges and boats.



Bridge Under Construction.

The bridge is designed to allow of the uninterrupted passage of boats and barges along the canal (and also for heavy highway traffic) having a clearance of twenty-nine feet above water level.



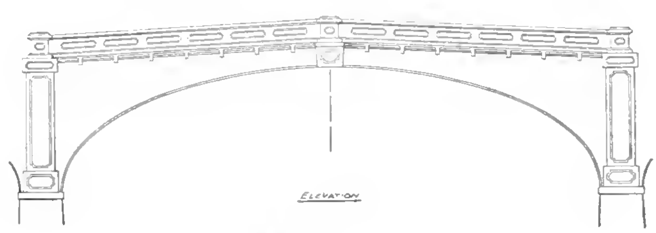
Longitudinal Section.

The main channel is spanned by a seventy-six-foot arch with a rise of 17.5 feet. The south approach consists of one arch span 62 feet, rise 14 feet; one arch span 50 feet, rise 11.5 feet, and about 30 feet of retaining wall, which completes the approach to the north side of Echo Drive. The north approach consists of three arches with spans 62 feet, 50 feet, and 40 feet, and rises of 14 feet, 11.5 feet and 8.7 feet respectively, and 230 feet of retaining wall.

The south abutment of the bridge (a section of which is reproduced) is of a 1:3:6 gravel mixture up to the springing line. At the base it is 25 feet 6 inches, and at the springing line 10 feet. The height of the abutment to the springing line is 24 feet.

The piers are of the same proportions as the abutment; they all rest on a good, sound gravel, free from clay of any kind, and are carried about five feet below the canal bottom.

The main arch is 76 feet, with a rise of 17.5 feet. A 1:2:4 mixture of broken stone concrete is used, reinforced top and bottom with ⅞-inch square steel bars placed 12-inch centre to centre, and tied together both vertically and horizontally with ½-inch square steel bars at 3 feet centres.



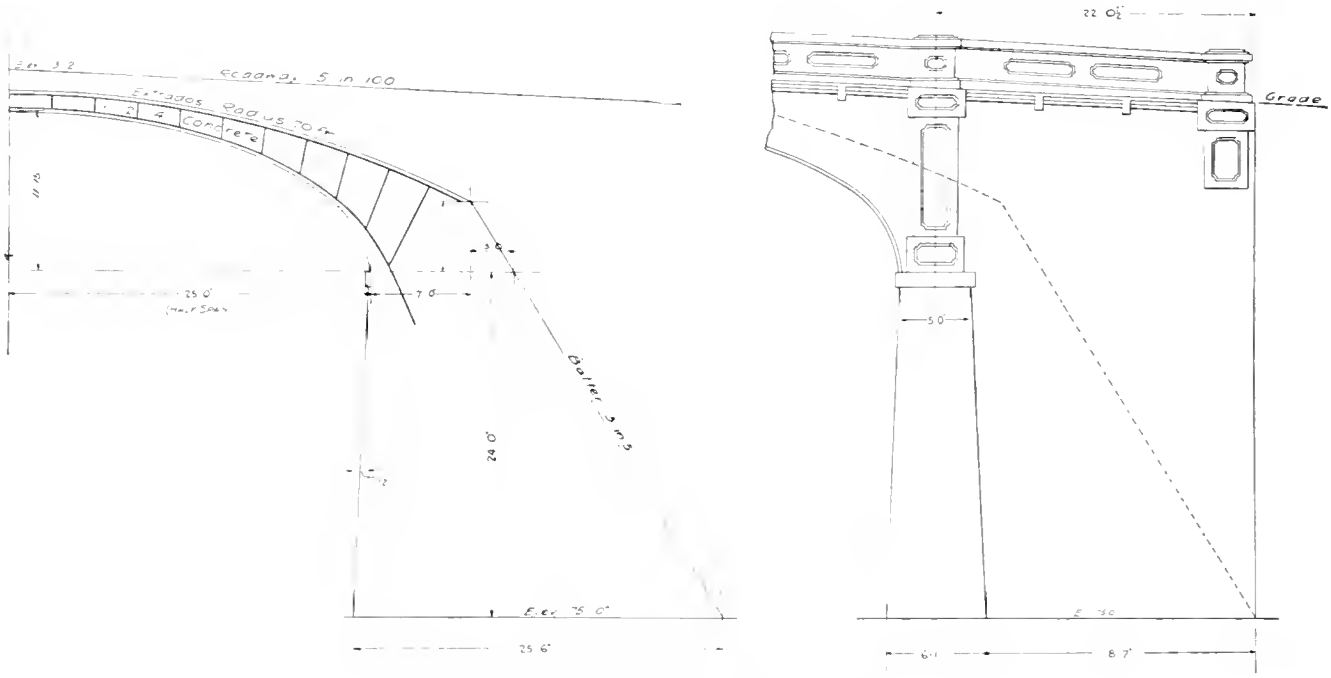
Elevation of Span.

The whole structure has been designed to conform with the specifications of the Department of Railways and Canals.

The Ottawa Improvement Commission's driveway will be continued under the north arches, through to the exhibition grounds, along the north bank of the canal as at present.

* City Engineer's Department, Ottawa.

The roadway, which will have a grade of five per cent. on both approaches, will be 40 feet between walks, and will be paved with creosoted wood blocks. The sidewalks will both be eight feet in width, and conduits will be placed under them to accommodate the cables and wires of the different electrical companies, thus doing away with the unsightly overhead wires. The ornamental lamp posts will be combined to carry the trolley wires of the electric railway and a cluster of four lights.



South Abutment, Bank Street Bridge.

Top of Arches With Reinforcing Bars in Place.

The construction work is nearing completion, everything being completed excepting the main arch, which has the centering and reinforcements ready to receive the concrete. This will be done immediately milder weather is encountered.

During the summer months between sixty and eighty men were employed; the number varying with the particular work in hand. Two steam derricks and two Smith mixers were kept constantly at work. A larger plant would have been difficult to handle, owing to lack of room at the site.

In concreting the arches, the concrete already mixed was hoisted with the derrick boxes to a temporary platform above the arch, and these emptied from it into wooden flumes which carry it to its place. Great care was taken to see that all the reinforcing was properly held in place among concreting.

The total estimated cost of the bridge, including land damages, is $130,000. Messrs. Jones and Girouard, of Ottawa, are the contractors.

Mr. S. D. Parker is the resident engineer on the works.

PORTABLE MIXING PLANT.

The new piers and wharves of the Balboa terminals, Panama Canal, will be supported on concrete caissons, sunk to rock. A portable concrete mixer mounted on cribbing on a flat car so that the spout is 14 feet above the platform is coupled to a box car containing cement, and at the "flat's" other end are alternate cars of sand and crushed rock. Portable runways for wheelbarrows are laid along the tops of the cars. The train is moved ordinarily by an air winch which draws through stationary sheaves at the ends of the track a ⅝-inch hauling cable with connections to the ends of the train.

When the train has been "spotted" opposite a form which is ready the concrete is poured into it through a chute. As it falls from the chute it is caught on a circular wooden platform set over the inner shell, and distributed to the annular space by men with hoes. The placement is quite simple and proceeds at the rate of mixer output. As soon as the shell has been cast the train is moved to another form. The concrete is allowed to set for 24 hours and then the forms are removed and cleaned at a special platform for their storage, after which they are set up again on the operating platform. The caisson shell is allowed to harden for three days before removal to a storage yard. Each section of shell is six feet high, with an inside diameter of 5 feet 6 inches and a thickness of shell of one foot, and contains 4⅔ cubic yards of concrete.

PORTLAND CEMENT TESTS.

At the meeting of the International Association for Testing Materials, the question of accelerated tests for constancy of volume in Portland cement, was under considerable discussion. In last week's issue of *The Canadian Engineer* we published a portion of a paper by Professor Max Gary as regards tests of this description in Germany. That portion of Professor Gary's paper which deals with accelerated tests in France is now given.

Accelerated Tests in France.—According to the paper by Mr. J. Bied during the last 20 years or so, hot water tests have been currently applied to hydraulic binding media in France, and the employment of the Le Chatelier needle cylinder apparatus for this purpose has been absolutely general and free from any objection. It is therefore perfectly natural that a French industrial laboratory should have taken up the matter of investigating the value of the objections raised against the method by the committee on the time of setting and by Messrs. Strebel in Germany and Butler in England.

Having read with a fair amount of attention the publications on this subject, I think that, leaving out of consideration the question of knowing whether or not the expansion in cold water previous to immersion in hot water should be disregarded—which point is quite independent of the test itself—the objections urged against the Le Chatelier hot test can be reduced to three:—

(a) The test would lead to the rejection of cements which would have behaved well in cold water.

(b) If the test be applied immediately after grinding, it will lead to the passing of cements which would, on the contrary, be rejected if the test were not applied until after aeration for a fortnight or a month.

(c) Finally, the test lacks precision, and furnishes results deficient in concordance, when employed in the same or in different laboratories.

These three objections will now be examined in turn.

The Le Chatelier test is likely to cause the rejection of good cements.

Here it is at once necessary to state the case properly, which does not seem to have been done. From a general point of view, the reproach is perhaps well founded, for I have kept in my laboratory for several months specimens of cements which gave an expansion of 50 mm. under the Le Chatelier test without exhibiting any trace of expansion in cold water. If, however, one takes up the point of view of the consumer, the reproach is unfounded, for the two following reasons:—

(a) The Le Chatelier test seems to eliminate all bad cements; and this is the main thing.

(b) Any manufacturer who knows his business can, without any sensible addition to the cost of production, make cements that will pass the Le Chatelier test.

Though it is not my place to point out what means should be adopted to attain this result, I am certain that many manufacturers, and those not the least important, will be entirely of my opinion.

Under these conditions the question of knowing whether the Le Chatelier test eliminates certain good cements should not even be mentioned by cement makers. The consumers are the best judges of the guarantees with which they should surround themselves, whilst the only part the manufacturers should play is to advise consumers on the possibilities of manufacture.

In the present instance, however, it is possible, without increase of cost, to manufacture a cement which will satisfy the Le Chatelier tests; and it is for the consumers alone, and not the manufacturers—one would think—to take up the matter.

It would seem, a priori, that the fact that cements which, though non-expanding when freshly ground, expand after aeration is due to the action of the added calcium sulphate on the calcium aluminate present in the cements.

A long time ago Candlot showed that cements which are retarded by the addition of gypsum, resume their quickness of setting after being aerated. According to Camerman, this little recognized phenomenon is the real cause of numerous accidents.

The company with which I am connected only makes cements which are excessively siliceous and do not contain more than 2 or 3 per cent. of alumina, so that it might be expected that the tests essayed with these would be less decisive than in the case of normal Portland cements. Nevertheless, they were not sufficiently so to be worthy of consideration.

A check specimen of the siliceous cement was mixed with 1, 2, 3 and 5 per cent. of its own weight of gypsum. The Le Chatelier test was applied immediately after mixing, and also after storage for 15 days in the open air.

Eight cylindrical test pieces were prepared from each product, and all the moulds were new and from the same source. After being made, they were kept in water at 17 deg. C. for 24 hours, between two sheets of glass, and then immersed in cold water in a water bath, the temperature of which was raised to 95 deg. C. in half an hour, and maintained thereat for 4½ hours.

A summary of the results indicates that aeration lessens the expansion of the check specimen and of the cements containing 1 and 2 per cent. of added gypsum, but increases the expansion of the test pieces with 3 and 5 per cent. of gypsum. The increase, however, is too small for the experiments to be considered decisive, and they consequently need to be completed.

The third objection urged against the Le Chatelier test is lack of precision.

It would perhaps be interesting in the first place to define what is to be understood by precision. There is no doubt that the Le Chatelier test does not attain the precision sought and obtained by Regnault in his experiments; but that it is not at least quite as accurate, as the other customary tests applied to hydraulic binding media remains to be proved.

After a series of tests carried out with new moulds from the same source, we have investigated successively:—

(a) The influence of the width of the shoulders by which the needles are fixed on the test pieces;

(b) the influence of the age, or degree of wear, of the moulds;

(c) the influence of the method of storage;

(d) the influence of the time elapsing between the final setting of the cement and the immersion in hot water.

From this series of tests it may be concluded that the form of the needle shoulder, and the age of the moulds, or rather the extent to which they have been used, have an influence on the results obtained, while the mode of immersion has but little influence; and that, on the contrary the results are influenced considerably by the time elapsing between the definitely ascertained completion of setting and the immersion of the test pieces in hot water, at least in the case of products with slow initial setting.

It is, in fact, characteristic of the Le Chatelier test that it does not give the measure of the absolute expansion at a given moment, but rather the difference between the effort of expansion and the effort of resistance opposed to this expansion by the cement in consequence of its own previous hardening.

May one not, however, base on this fact for the purpose of removing the reproach that the Le Chatelier is excessively severe? It would be sufficient to examine merely whether the delay of 24 hours after mixing is adapted for all eventualities, or whether it is not too strict, and that by altering the period to 36 or 48 hours one would still meet with the inconvenience of eliminating the cements that are stable in cold water. Moreover, in our opinion, the period allowed to elapse previous to the immersion in hot water has nothing to do with the value of the test. It should be left for each user to fix for each class of cement the period that should be allowed to elapse before the Le Chatelier test is applied.

On the other hand, the results obtained having revealed the slight influence of the method of keeping and of immersion of the test pieces in hot water, and the complete concordance of the tests performed with moulds of one and the same origin, it is in our opinion justifiable to regard the Le Chatelier test as being sufficiently accurate in practice and convenient for use. As regards the shape of the needle shoulders, nothing is easier than to contract this by regulation, in the same manner that one can fix the number of times the moulds may be used before being discarded.

WASTE DESTRUCTION.

Writing in the Municipal Journal, C. E. Crichton, M.D., Commissioner of Health, Seattle, Wash., has the following to say concerning waste destruction in the city of Seattle:

The term waste, as used in the city of Seattle, includes everything on earth that is wasted, deposited or thrown away as being of no further value to the person or persons producing the same.

The city of Seattle, after an exhaustive investigation made, has seen fit to divide this subject into three headings: 1st, Collection; 2nd, Removal; and 3rd, Destruction. The commissioner of health of this city spent one year in visiting the principal foreign nations, the different cities of Canada and the United States and made an exhaustive study of the methods of collection and disposal of waste material.

He believes that by far the most dangerous substances which should be collected and destroyed by the ordinary American city, are those which as a rule receive the least attention. Most cities attempt to make a regular collection of what is generally known as garbage, decaying vegetable and animal tissues. Many American cities collect only at convenient times, and some only once or twice a year, other wastes, which in Seattle are considered the most dangerous. We refer to old mattresses, sheets, soiled bedding, wall paper, carpets, rags and handkerchiefs which have been soiled by direct contact with the evacuations and secretions of those sick with typhoid fever or other communicable diseases, more particularly tuberculosis.

In visiting 28 of the leading cities last summer we found some of those classed as progressive and modern collecting this most dangerous waste only twice a year. It can be seen at a glance that, while table refuse or true garbage may become annoying to the special senses, the material is as harmless as it was before it passed through the kitchen. It is, of course, a feeding ground for flies and rats and to a certain extent furnishes a breeding place for the former.

We adopted the single can collection, into which every known substance is thrown and same collected regularly, because by so doing we cause an immediate destruction of the dangerous wastes and because it gives a mixture of ashes and other wastes with true garbage. It has been found by actual experience to limit the smell from the garbage can and the ashes, being a good absorbent, keep the insides of the cans comparatively dry. This step also enhanced the beauty of the city, since rubbish and refuse are never in evidence for more than a week's time. First of all, let us say that the collection and destruction of garbage was considered as a sanitary measure, and that the cost of collection, removal and disposal was subordinated to that of sanitation. After we had decided upon the most sanitary plan, we then sought to procure the most economical method of collection, removal and destruction.

We have given the matter of removal separate treatment because this city introduced the method of removing its waste by auto truck two years ago and to-day is removing nearly 30 per cent. of its waste in this manner. It is believed that within sixty days more than 50 per cent. will be removed by the auto truck. The removal of a city's waste is much more important than is conceded by most city officials. In removing the same by auto truck the material is taken through the streets of the city in about one-fourth or one-fifth of the time consumed by horse-drawn vehicles. Seattle is a city of hills and it is therefore safe to say that this material is removed as a matter of fact in one-fifth of the time consumed by horse-drawn vehicles. Six tons are removed in one truck bed built for this purpose. It is more easily covered by tarpaulin than would be the same tonnage in three vehicles. It is dumped once instead of three times, thus saving the blowing about and dissemination of disease-bearing germs. Not as many garbage-laden vehicles pass through a given community nor are they repugnant to the people as are horse-drawn vehicles. The collections are more regular because our hillsides are slippery during certain seasons and we were occasionally delayed a day or so at a time, as the case might be, by the use of horses.

In considering the great question of disposal, the one idea dominating at all times was that purification and destruction by fire was far and away superior to any other method. As a consequence, we early adopted the Meldrum Brothers furnace, of Liverpool, England, which is a forced draft, high temperature furnace and did what every American city should do, provided it adopts such a furnace, and that was to buy the right to the patents to build these plants, as many as desired within our corporate limits. This foresight has enabled the city to have in operation to-day three of these destructors, capable of consuming slightly more than 200 tons of mixed waste daily. Right here let it be thoroughly understood that not one pound of fuel is used in our destructor other than the waste itself—no coal, no wood, no oil. We have in the treasury to-day funds for the building of two more units. A unit has a guaranteed capacity of 65 tons of garbage daily. The Heenan & Froude incinerator now operating in Milwaukee is a type of furnace very similar to the one used here. Such furnaces turn out a clinker, or more properly speaking a slag, which we run through regular rock crushers and which is used for practically the same purpose as is crushed rock. We find a steady market for this material for use in paving and sidewalking, and especially for floors in fireproof structures. We sell at the bunker, receiving 75 cents per cubic yard. We also grind the clinker still finer when it is used for many purposes like the manufacture of stationary wash trays, etc.

The wagon which Seattle has adopted for general waste collection is the old type of European rear dump with large hind wheels and small front wheels which allows for turning within the length of the wagon. The rear wheels being high gives us ample opportunity for dumping large bulky material without annoyance. In one single can collection are boxes, barrels, shrubs, limbs of trees and other matter, and as a consequence there must be considerable clearance from the wagon-bed to the ground or there will be difficulty in dumping. Where we are dumping into the bunkers this is not quite so important, although it has its advantages.

The can which we allow to be installed must not contain more than 35 gallons, and is about 18 x 30 inches in size. However, for waste-paper we allow a larger can. Cans must be placed in suitable and accessible locations where they can be conveniently handled and loaded, since the time consumed in loading a ton of waste when taken from cans convenient and accessible as against cans inconveniently located amounts to practically 27 per cent.

We have not been operating with the auto trucks long enough to know exactly what the saving is amounting to over the horse-drawn collection. It is our opinion at this time, however, that we are collecting with the auto truck our waste at a saving of not less than 45 cents on the dollar. We have attempted to lessen the price of the haul by installing at different places in the city small bunkers arranged in cells, each cell having a capacity of about six tons. These are filled by the horse-drawn vehicles. This material is taken from the bunkers by the auto trucks to the incinerators and also at the present time to a large open dump. Five of these auto trucks are being used by the city in this work. They are the rear dump with bed 11 feet long and 6½ feet wide. By the use of these trucks we save the long team haul, the most important money-saving feature of our entire scheme.

The two new furnaces we have installed have each an auxiliary boiler. These were placed with the idea of allowing the sale of steam. We develop 225 h.p. at each plant, but on account of the drawing of our fires about once in four hours, we find it necessary, in order to guarantee the sale of steam, to install the auxiliary boiler, its furnace to be fed with the same material, i.e., the city's waste.

TABLE OF MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC DURING 1912.

Substances.	Production, 1912. Quantities.	Value.	Value in 1911.
Asbestos, tons	111,175	$ 3,059,084	$3,026,306
Asbestic, tons	25,471	23,358	19,802
Copper and sulphur ore, tons	62,107	631,963	240,097
Gold, ounces	980	19,924	11,800
Silver, ounces	26,526	14,591	11,500
Bog iron ore, tons...	....	...	4,041
Ochre, tons	7,054	32,010	28,174
Chromite, tons	....	....	2,469
Mica	....	99,463	76,428
Phosphate, tons	164	1,640	5,832
Graphite, pounds	1,210,278	50,680	33,613
Mineral water, gals..	39,452	9,854	65,648
Titaniferous ores, tons	2,949	4,935	5,684
Slates, squares	1,894	8,939	8,248
Cement, barrels	2,684,002	3,098,350	1,931,183
Magnesite, tons	1,714	9,645	6,416
Marble	...	250,939	143,457
Flagstone	....	600	500
Granite	...	358,749	308,545
Lime, bushels	1,705,937	455,570	284,334
Limestone	....	1,361,082	1,128,402
Bricks, M	100,146	1,284,232	1,129,480
Tiles, drain and sewer pipe, pottery, etc...	....	203,100	142,223
Kaolin, tons	40	520	....
Feldspar, tons	110	2,200	600
Peat, tons	500	2,000	700
Glass sand	152	418	1,179
Sand	81,800	33,200	62,000
Quartz	....	....	1,125
	....	**$11,017,046**	$8,679,786

Records an increase of $2,337,260 in 1912 as compared with 1911. For the last ten years, the record of increase of each year over the previous one has been unbroken, as the following table shows:—

Table Showing the Annual Value of the Mineral Production of the Province of Quebec Since 1903.

Year.	Value.
1903	$ 2,772,762
1904	3,023,568
1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,679,786
1912	11,017,046

Notes on Mineral Production in 1912.

Asbestos.—Asbestos, as in the past years, heads the list of the products of the Quebec mines in 1912. After having passed through a severe crisis, the asbestos market is steadily improving. This is specially true for the higher grades, crude and long fibre mill-stock. The demand for the short mill-stock is not brisk, and, as a consequence, the qualities under $30 a ton have to be sacrificed to some extent.

Therefore, under these circumstances, of good prices for high-grade stock and low prices for short mill-stock, it is quite easy to understand that only the mines which can produce the better qualities are able to operate satisfactorily. Hence, none of the mines of the Broughton district were operated during 1912, as the Broughton rock is essentially a milling rock, containing as a rule a gool percentage of disseminated fibre, but short and low in value. The same remark applies to most of the mines of the Robertson district.

On the other hand, the Thetford mines and the Black Lake mines worked steadily and the shipments are higher than for 1911.

WATER REQUIREMENTS OF A LARGE RAILWAY SYSTEM.

At the meeting of the Illinois Water Supply Association C. R. Knowles, general foreman of waterworks, read a paper, of which the following is an abstract:—

The consumption of water by railway systems has greatly increased, and it has been necessary to raise the standard of the supply, both in quantity and quality, to meet traffic conditions. In former years it was the practice to erect a tank and establish a water station at any point where water of any kind was most convenient, with little regard to the quality or future requirements. This has necessitated many changes to meet the new conditions and added requirements, such as relocating water stations with due regard to curvature, grades and the many previously unknown expedients of operation.

To accomplish these results it is often necessary to pipe water a considerable distance, or, if an ample supply is not otherwise available, to sink wells or construct a reservoir impounding a storage supply. In the event that the available supply is not satisfactory in quality, it is often necessary to erect treating plants to convert it into a suitable water for locomotive purposes. All these changing conditions and increasing requirements have made it necessary to maintain a waterworks department organization, whose duties are similar to those of a city waterworks department.

The amount of water required for all purposes by one railroad 6,500 miles long is approximately 16,500,000,000 gal. annually. In the State of Illinois, on 2,000 miles of road,

4,236,838,000 gal. of water was used for locomotives alone, of which 1,751,790,000 gal. is purchased from municipal and privately-owned waterworks plants and 138,645,000 gal. is treated by purifying plants owned by the railroad. It is necessary to maintain 123 water stations to distribute this water to locomotives. In addition to the above, the washing and filling of locomotive boilers at terminals requires approximately 950,000,000 gal. per annum, which is provided by the same pumping plants with additional facilities for maintaining the desired pressure for washing the boilers and the necessary pipe line for the distribution of this water under pressure.

Stationary power plants also require approximately 300,000,000 gal. per annum, including water used for condensing engines, of which 125,000,000 gal. is city water. It is estimated that 250,000,000 gal. additional is required for miscellaneous purposes at shops, roundhouses, offices and stations. This makes a grand total of 5,736,838,000 gal. of water used for all purposes by this one road in Illinois alone.

CITY PAVEMENTS.

By C. C. Powell.*

For the benefit of those readers who were not fortunate enough to be able to attend the recently held annual meeting of the Ontario Good Roads Association, we publish the following abstract of the paper presented by Mr. Powell before it.

During my experience in Toronto I have found that the people are, as a whole, greatly interested in the question of pavements, and will generally take the initiative in this matter; in fact, demands for pavements are often made by property owners before the sewers are constructed, and during a period of great real estate activity the requests for pavements of one kind or another are so great as to tax the best efforts of the Works Department to keep up with them.

The pavement work of Toronto is all carried out on the local improvement plan:

1. On petition.
2. On the initiative or without petition.
3. On the initiative by ⅔-vote of council.

1. When a work is undertaken on petition, the requirements are as follows:—A petition form must be obtained from the Works Department giving the description of the street to be paved, width of pavement, cost per foot frontage, annual cost per foot frontage for the life of the pavement, and in order that the people to whom this petition is presented may have an opportunity of knowing the cost of any other pavement, a table of these costs is printed upon the petition form. This precaution is taken so that a person signing a petition can not plead ignorance or misrepresentation in regard to the price to be paid. Such a petition is considered sufficiently signed when it bears the signatures of sixty-six per cent. of the property owners, representing fifty per cent. of the property value.

When a petition is presented and declared to be sufficiently signed a recommendation is made to the council, and if passed by that body the work may be proceeded with.

2. If a work is deemed necessary by the Works Commissioner a recommendation is made on the initiative. When this recommendation passes council, notices are sent to the property owners, and a month is allowed for the owners to petition against the improvement. If no petition is received within this period, the work may be proceeded with. A petition against, to be sufficiently signed, must have the signatures of a majority of the property owners, representing at least half the property value.

3. In cases where trouble is experienced in getting a local improvement laid and where such an improvement is deemed necessary by the Works Commissioner, as being in the public interest, a recommendation is made, and if passed by a two-thirds vote of council the work may be proceeded with, notwithstanding any objections or petition against by the property owners.

With machinery as outlined above, a municipality is well equipped for carrying out any campaign for street improvements that may be decided upon.

The question of the selection of a pavement for a given street is often a difficult one where there are so many kinds to choose from, but, generally speaking, the elements that enter into this selection are:—

1st. Durability, having regard to the traffic to be expected after paving.
2nd. Grade.
3rd. Cleanliness.
4th. Cost.

Permanent pavements are now generally recognized as being best for the more or less heavy traffic to be encountered in a city, and practically no other pavements are being constructed in Toronto. Permanent pavements are generally defined as those baving a concrete foundation, and the practice has been to vary the depth of concrete foundation according to the traffic. These depths vary as follows:—

4" for light traffic..
5" for medium traffic.
6" for heavy traffic.

The so-called permanent pavements are divided as follows:—

1. Sheet pavements.
2. Sectional pavements.
3. Monolithic pavements.

Under sheet pavements are included asphalt, asphaltic concrete, tar concrete, bitulithic, and a number of other patented bituminous pavements.

Sectional pavements comprise brick, stone setts, wooden block and asphalt block.

Monolithic pavements include the various forms of concrete pavements and probably asphalt macadam and tar macadam can be included in this list.

For our guidance in selecting a pavement for a given street, the following table has been made, viz.:—

Up to 3% grade	Any pavement.
From 3% to 5%	Brick, stone sett, asphalt macadam, asphaltic concrete, concrete macadam, rocmac, bitulithic, asphalt block.
From 5% to 7%	Brick, stone sett, macadam, rocmac.
Above 7%	Macadam and rocmac.

For heavy traffic the pavement most in use in Toronto is asphalt, although brick and wooden block have been laid in a number of cases.

The merits of the brick pavement are apparently not very highly appreciated in this city, as almost invariably our recommendations for a pavement of this material are petitioned against, the only reason given being the noise. The repair bill on our brick pavements is much smaller for the same area than for any other pavement.

In the residential districts asphalt, and bitulithic are about the only two pavements laid, although it is expected that asphaltic concrete, asphalt macadam, or rocmac will be laid in increasing quantities as time goes on.

A patented pavement is not recommended unless a sufficiently signed petition has been received asking for such a

*Deputy City Engineer, Toronto, Ont.

pavement. The sheet pavements have reached this popularity for residential streets due largely to their comparative dustlessness and lack of noise.

The standard width of pavement adopted in Toronto for a main thoroughfare, 86-ft. wide, where tracks are laid, is 54-ft. from kerb to kerb, allowing 18-ft. of pavement on either side of the track allowance, or 19' 3" if we include the blocks next the rails. This width provides for two lines of traffic. Where the street is only 66' wide and tracks exist, the standard is 42-ft., giving a pavement 13' 3" on either side of the track allowance, including the blocks next to the rails. On residential streets, the standard width of pavement is 24-ft., although in the past some pavements as narrow as 18-ft. have been constructed. Pavements of greater width than 24-ft. are laid where traffic conditions warrant it. There is now an agitation to have the standard width for residential streets increased to 28-ft. The agitation for this increased width is due to the increase in motor vehicles and the desire of their drivers to be able to pass slow moving vehicles with less inconvenience.

I am of opinion that such a provision is good in so far as the more important thoroughfares are concerned, but it is a hardship to force people to pay for a pavement of greater width than is needed for the traffic of the street, and it will also increase the cost of maintenance materially.

The crown of pavements in a city is also a very important question, and while a high crown tends to increase the life of a pavement by causing the surface water to run quickly to the gutters, it is very hard on horses in frosty weather and in summer time when flushing is being resorted to. This difficulty has become so great during the past year or two that we are now reducing the crown of all new pavements very materially. A few years ago the standard crown for a 24-ft. asphalt pavement was 6". In 1911 this was reduced to 5" and a further reduction to 4" is now contemplated.

Drainage troubles in the construction of city pavements are not very serious, for, as a general rule, the streets are provided with the necessary storm sewers for taking care of the surface water. Catch basins are constructed on opposite sides of the street about every 300-ft., with large openings so that the surface water may quickly reach the sewers. These openings are provided with suitable grates to prevent larger solids from entering the catch basin, and a trap is usually provided to prevent the escape of sewer gas, and also to keep floating rubbish from entering the sewer. In order that the catch basins may be kept clean they are provided with a semi-circular bottom which enables the long scoop to be effectually handled. The main difficulty in connection with surface drainage that has to be contended with in Toronto is getting rid of the water on some of the east and west streets where the grade is practically level. This is usually accomplished by what is termed false grading, that is, the face of the kerb is increased at the catch basin, and decreased at a point some distance away. In this manner five to three inches of additional fall may be secured, which will effectually carry away the water.

One of the most important features of pavement work as carried on by a municipality, is inspection, and as a general thing, great attention is given to both inspection of materials and supervision of the work, to see that the provisions of the specifications are being carried out.

The city of Toronto is provided with a good testing laboratory, in charge of a capable chemist, in which all materials are carefully inspected. Every carload of cement used on city contracts must pass the ordinary seven day test, before used on the work, and if any doubt is aroused as to its soundness, it is held for twenty-eight days. All asphalt, asphaltic mixtures, fluxes, etc., are investigated in the same way, so that the city is reasonably sure of good work, notwithstanding the five year guarantee exacted.

The sand and stone that are used in the manufacture of a pavement must also have careful consideration, and to this end numerous sand and stone gradings have to be made each year to verify the standards laid down in the specification.

The organization in force to look after the actual construction work is as follows: A district superintendent in charge of all contract work in a given district, and under his care sufficient inspectors and time-keepers to take care of every branch of the work. The city also does a good deal of work by day labor.

Probably the feature that gives rise to the greatest amount of controversy between the Engineering Department and the property owners is the question of grade, and the greatest care has to be exercised at all times to see that the grade established on any street does not give rise to claims for damages. Apparently it does not matter whether you cut or fill, the claims for damages appear just the same. Little or no difficulty is experienced in the older parts of the city, but when we start to work on some of the newly annexed portions of the city we are met by conditions that are hard to overcome; buildings have been erected without regard to probable street levels, and as a result the grade has to be mutilated in order to provide proper access to the property.

To overcome this trouble in the future, the department now gives building grades to intending builders and any new streets accepted by the city are only accepted on condition that no claims for damages will be made by reason of the grade established for the roadway.

Instances have occurred in certain parts of the city, where 12 per cent. grades have been established because the cutting or filling necessary would have practically destroyed the adjacent property.

The costs of the various pavements are as follows:—

2" asphalt, 1" binder, 6" concrete	$2.25
2" asphalt, 1" binder, 5" concrete	2.00
2" asphalt, 4" concrete	1.60
2" asphalt, 1" binder (surface only)	1.05
3" asphalt block, 4" concrete	3.45
2" bitulithic, 4" concrete	2.15
2" bitulithic, 5" concrete	2.30
2" bitulithic (surface only)	1.75
Brick on 4" concrete (Canadian)	2.55
Brick on 4" concrete (American)	2.75
Brick on 6" concrete (Canadian)	3.00
Brick on 6" concrete (American)	3.20
Wooden block on 6" concrete	...

The concrete foundation work is composed of:—1 cement; 3 sand; 7 stone.

By instruction from council the Works Commissioner has to submit a tender for all work advertised, with the exception of large bridges and buildings for which special plant is required. As a result the department does a good deal of work by day labor.

In order to carry out this work economically and efficiently, adequate plant and superintendence is necessary. Last year council sanctioned the purchase of a great deal of plant for sewer and roadway construction, which will place the department in good shape to undertake any work of this character that it may be called upon to do. In addition to good plant a force of efficient foremen and superintendents is necessary, and I am glad to say that the city is as well provided with good men to fill these positions as any similar organization anywhere. The day labor work is carried on as a separate branch of the roadway section, with its own superintendents and timekeepers.

The maintenance of city pavements is probably the most important feature, and at the same time the most difficult to properly carry out, but after a good deal of experiment a

scheme has been adopted which will probably give good results. The city is divided into comparatively small sections, and in each one of these sections is located a district foreman who has a store yard, and sufficient men at his disposal to properly patrol the streets and to make the necessary repairs without delay. The additional plant spoken of above will provide us with enough rollers and other plant to do this.

A special feature of this organization is that at definite intervals a report will be made showing the condition of all streets in the city, and will enable the department to plan future work a long way ahead.

One of the most troublesome features of maintenance work is the repair of cuts made for the installation of water services, gas services, and private drains, and apparently in Toronto, nothing has yet been devised to prevent this trouble, although frequent attempts have been made. In some cities legislation has been obtained compelling property owners to have all these services installed before the pavement is laid, but here we have no such law, but are permitted by the Local Improvement Act to recommend both water and sewer services as local improvements, charging back the cost to the property affected. This is not an ideal provision, because property changes hands so frequently and services installed to suit one individual would have to be changed to suit the next, who might desire to arrange his buildings on the lot in a different manner, and, as a consequence, the pavement would have to be cut.

By co-operation with the various public utility corporations it is expected to reduce this cutting to a minimum this year, and it is hoped that all cuts made will be promptly repaired as they will be reported at certain fixed intervals by the patrolmen.

In 1908 the civic asphalt plant was put in operation, and since that time all repairs to pavements out of guarantee, and a good deal of new work has been carried out by the department. Costs have been reduced and a more satisfactory condition of the streets has been maintained. In no time since 1907 has our cost exceeded 77c. per sq. yard..

The city has also a small crushing plant, a No. 4 Austin (Gates) gyratary crusher with a fairly large capacity. This crusher is used to crush old material that comes off the street, and which can be used again as broken stone for concrete in track allowance foundations. This plant enables us to use up material that would otherwise be wasted or remain in the store yards for an indefinite period.

It is also a great convenience in times of shortage of broken stone, for the rubble can be secured and crushed and some of our jobs kept going.

HEATING PIPES UNDER FLOOR.

Heating a building by means of steam pipes embedded in the concrete floor has been successfully accomplished in the chassis testing building of the Moline Automobile Co. at Moline, Ill. The structure is 120 ft. long by 60 ft. wide, with door openings extending completely across the ends of the building.

The workmen are obliged frequently to lie on the floor in making necessary repairs and adjustments, and on this account it was desired to keep the floor surface comfortably warm. To accomplish this, 1¼-in. steam pipes, spaced 42 in. on centres were laid 2 in. below the surface of the 6-in. floor slab. The concrete is reinforced locally against cracking, due to the expansion of the steam pipes, by corrugated, galvanized iron pipes inclosing the former.

Below the floor slab, 8 in. of cinder fill are placed as an insulating material. It is stated that with only five small metal radiators additional, it is possible to obtain a uniform temperature of from 60 to 70 deg. F. throughout the building.

STREET LIGHTING TESTS.

A description of the tests and comparative results obtained from high pressure gas lamps and high candle power arcs was given lately at the Institute of Electrical Engineers, England. The tests were carried on in Manchester, and the paper on these tests by Messrs. S. L. Pearce and H. A. Ratcliff, is given herewith.

Gas Installation in Princess Street.—Four high-pressure lamps were suspended in Princess Street at the same height above the roadway as the arc lamps—namely, 27 ft., 6in. The distance between the lamps varied from 95 ft. 6 in. to 118 ft. 9 in., but 106 ft. 6 in. might be taken as approximately the average.

Each lamp contained three inverted burners, and clear globes were used. At normal pressure each burner was rated at 1,500-candle power, or a total of 4,500-candle power for the complete lamp; but the maximum candle power obtained was only about half this figure.

As originally installed the lamps were fitted with traversing and lowering gears; but these were apparently not successful, as the lamps were at a later date fixed permanently in position. The flexible gas supply tubing was also replaced by rigid galvanized gas barrel.

Princess Street is 60 ft. wide, and as the lamps were, on an average, only 106 ft. 6 in. apart, the resulting illumination was very good, and far superior to any previous example of high-pressure gas lighting in Manchester.

Presumably in order to improve the maximum illuminating effect, but certainly not the uniform distribution of the light, the lamps have been lowered about 1 ft.

Arc Lamps in Portland Street.—The central suspension system was chosen for the lighting of Portland Street, and certain predetermined "units" of light were erected at such calculated distances apart as to give the maximum illumination for the least capital expenditure.

The paper points out that in addition to low initial costs the central lighting system has the following advantages, which appear to outweigh certain known disadvantages:—

(a) The distributing mains can all be kept to one side of the street.

(b) No separate lighting standards are required on the street pavements, with consequent advantage to pedestrian traffic.

(c) A more even illumination is obtained; in other words, the ratio of maximum to minimum illumination is less than with side lighting for a given amount of electrical power employed

The traffic in Portland Street is of a very dense character all day long, and more especially between the hours of 4 p.m. and 6.30, and it was therefore deemed advisable to aim for a high standard of minimum illumination—viz., something of the order of 0.5 foot-candle. The minimum illumination at any point on a horizontal plane at ground level was expected to be not less than 0.44 foot-candle. This figure was not obtained with the lamps as at first installed, but has since been exceeded.

The length of Portland Street is 1,751 ft., and its width 66 ft. Sixteen 550-watt lamps, working four in series on the 200-volt mains, have been erected. Owing to the positions at which certain important side streets intersect the main street, the distance between lamps varies from 114 ft. to 124 ft.

Eight of the sixteen lamps are run on an all-night circuit, and the remaining eight are switched off at 11 p.m. The lamps are so arranged that, when all sixteen are burning, the lighting is balanced across the three-wire distributing mains; but after 11 p.m. the remaining eight lamps are connected to one side of the system only. The lamps are

fixtures, in so far as no provision has been made for lowering or drawing them to the side of the street. All trimming has therefore to be done from a tower wagon. This decision was come to after carefully considering the extra expense and complication involved in arranging for lowering gear, and also with due regard to the type of lamp selected, the hours of burning, and the local conditions.

The first results obtained were not considered altogether satisfactory; the shadows under the lamps, thrown by the ash-trays, were most pronounced, as was also the series of concentric rings on the surface of the roadway. As fitted with clear inner and opalescent outer globes, the lamps gave a minimum candle-power on the 20-degree ray of 2,250. This was substantially lower than the result anticipated.

Photometric tests showed that the polar curve of the lamps with the particular inner and outer globes used did not meet the necessary requirements, and the resulting distribution of the light was very unequal. The shadows and concentric rings were practically eliminated by the use of slightly opalescent outer globes, but the efficiency of the lamps was impaired to a very appreciable extent, and the distribution of light was rather worse than before, the change from the dark zone midway between lamps to the bright zone adjacent to the lamps being very pronounced.

The paper mentioned that all the testing was done in the streets at night with the lamps burning under normal conditions, and consequently the results obtained are directly applicable to the requirements of practical work.

General Comparisons.—The authors proceeded to observe that any comparison of the Portland Street and Princess Street lighting other than on an "equal basis of cost and illumination" required to be very unbiassed, since there was much to be said in favor of both systems.

"The gas lamps give a much steadier light than the arc lamps, although the difference is not very noticeable to a casual observer, or even to a keen observer; but it is very noticeable when making measurements with a flicker photometer. . . . Unfortunately, although the gas lamps give a steadier light, their candle-power varies very considerably from day to day. The candle-power of a particular lamp may fall at least 50 per cent. before the mantles are renewed, unless it is arranged to change only one mantle at a time, thus spreading the complete change over a fairly long period.

"The candle-power of the arc lamps may vary quite appreciably within a few minutes; but provided that the same make of carbons is used, the average candle-power at any particular angle will not change to any extent from day to day if the line voltage is reasonably constant.

"A very important feature directly affecting the comfort of the general public is the absence or otherwise of glare. . . . Obviously the larger the surface of the light source in proportion to the total amount of light emitted the lower the intrinsic brilliancy and the less the effect of glare. In this respect the three-burner high-pressure gas lamps have an advantage over the flame arc lamps with clear inner and outer globes. The use of clear outer globes with flame arc lamps is, in fact, hardly advisable from the point of view of scientific lighting, since any form of lighting which is productive of eyestrain is essentially unscientific, and is certainly unsatisfactory.

"Two noticeable features in Princess Street are the comparative softness of the shadows of objects cast on the ground and the absence of a pronounced dark horizontal zone in line with the reflectors. The first result is, undoubtedly, due in a great measure to the fairly large triple light source, which has the effect of shading off the edges of shadows; and the absence of a dark zone in line with the reflectors is, no doubt, due partly to the fact that the source of light is well below the reflector, and partly to the reflection from the inner surface of the large globes. The shadows [illegible] by the flame arc lamps when burning with clear inner and [illegible] globes are very intense, and there is no appreciable shading [illegible] of the edges; consequently it is possible to confuse shadows with actual objects. The smallness of the light source, or, in other words, the high intrinsic brilliancy, and the fact that the arc is well up under the reflector, is no doubt the cause of the objectionable horizontal dark zone noticeable in cases where reflectors are used."

The Portland Street light is considered by the authors to have a much warmer and more cheerful effect than the comparatively cold light in Princess Street. The actual relative values of the two schemes of lighting is clearly shown by various tables and curves in the paper giving the results of photometric tests and the contour curves showing the portions of the street area within which the illumination on a horizontal plane is equal to or greater than 0.5 foot-candle.

"Purely from the point of view of illuminating effect," the paper adds, "there is much to be said in favor of both systems; but the electric lighting system possesses all the practical advantages, a few of the more important of which are: (a) Lower cost; (b) simplicity of switching operations, and possibility of dispensing with lamplighters; (c) flexibility and ease of erection; (d) lamps not affected by vibration when suspended from traction poles; (e) possibility of reliable check on running costs (i.e., current consumption and carbons); (f) negligible leakage; (g) absence of globe breakages due to heating, &c.

"All the above advantages are absent in the case of the high-pressure gas system, and in contrast may be mentioned the disadvantages incidental to its use: (a) Extensive and highly dangerous leakage of high-pressure gas; (b) the detrimental effect of a foggy or heavily smoke-laden atmosphere on the mantles, resulting in a serious diminution of candle-power just at a time when it is most required; (c) partial and occasionally complete failure in frosty weather."

Conclusions from the Tests.—Messrs. Pearce and Ratcliff expressed the view that the tests referred to in their paper had at least vindicated the lighting of city streets by means of flame arc lamps, not only on the dual basis of equal cost and illumination, but also on the ground of light distribution.

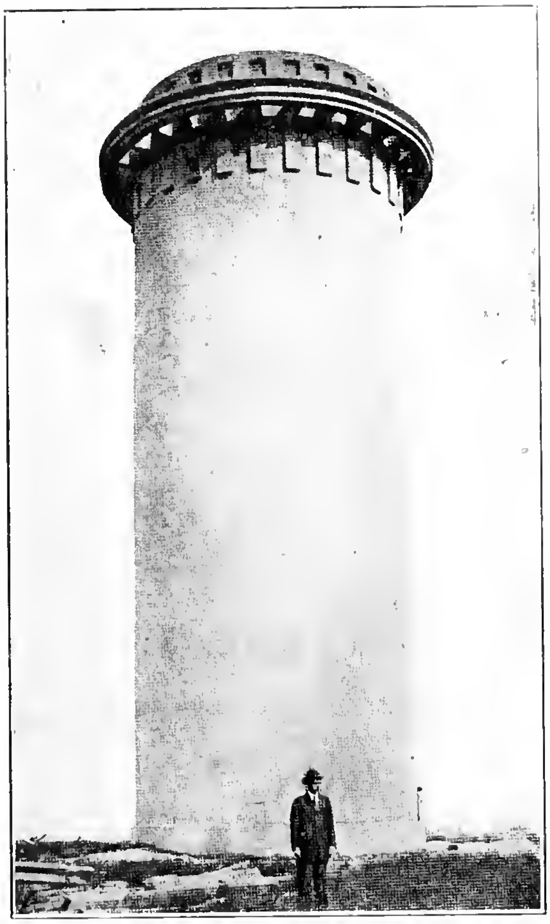
"Unfortunately," they remarked, "owing to many unavoidable difficulties, the experiments with various forms of frosted globes have not yet been quite completed.

As there was a substantial difference between the cost of the flame arcs and the high-pressure gas lamps for the same minimum illumination, it would be possible to improve the arc lighting, if considered desirable, by reducing the distances between lamps in the case of future extensions. If fixed at the present height, and 100 ft. apart, the minimum illumination would be not less than 0.75 foot-candle. No attempt had been made to obtain perfectly uniform illumination, since it was very doubtful whether such a scheme would be desirable, even if possible. A variation factor of 3.75 was not excessive if the change was fairly gradual; and in this respect partially frosted globes gave results quite as favorable as dioptric ones. A well-known authority on street lighting had expressed the opinion that perfectly uniform lighting was flat and uninteresting. From a purely psychological point of view that was no doubt quite correct; but there was probably a more definite psychological explanation. The visual conception of illumination was largely a matter of contrast, in connection with which fatigue of the eye played a very important part. It was therefore quite probable that the hollows in the illumination provided the rest necessary to enable the eye to appreciate the peaks, with the result that the average impression produced was superior to the corresponding effect due to a perfectly uniform system of lighting of equal average intensity.

REINFORCED CONCRETE STANDPIPE.

A standpipe at Belton, Texas, constructed of reinforced concrete, is described by T. L. Fountain, a graduate of Engineering at Cornell University, in the March number of Cornell Civil Engineer.

For many years, the water supply of Belton has been obtained from deep wells, storage and pressure for domestic purposes being secured by use of a steel standpipe located on a hill in the northern part of the city. The pressure thus afforded not being sufficient for satisfactory service to Baylor Female College, located on one of the highest points in the city limits, the height of the standpipe was increased about 30 feet. Several years ago the upper half of this standpipe was torn off by the wind, probably due to the weakness of the plates, which originally were near the top. The pressure and storage afforded by the lower half of the standpipe were so unsatisfactory that a bond issue for extending the mains to the south side of the city and erecting a new standpipe on a hill located there carried without opposition.



Standpipe Complete, Showing Ornamental Cornice and Other Decorative Work at the Top.

The chemical contents of the well water at Belton is such that it rapidly corrodes steel, but has no delterious effect on concrete. The cement mortar coat on the interior of the storage basin at the pumping plant is as sound as when put on 20 years ago, whereas service pipes and fittings all over the city deteriorate rapidly. On this account, estimates for the proposed new standpipe were secured on the basis of using much thicker steel plates than would ordinarily be required. No bids were taken, but the lowest quotation received for a steel standpipe 24 feet in diameter and 75 feet high was over $7,000. At this juncture, the firm of which the writer is a member was employed to prepare plans for the proposed waterworks improvements. Believing that a reinforced concrete standpipe could be constructed at a lower first cost which would last indefinitely without any expense for maintenance or repairs, the design shown in Fig. 1 was submitted to the city, and, upon its approval, work was immediately commenced.

Design.—In the design of this standpipe, certain assumptions were made which resulted in securing its construction at a cost very much less than for a steel standpipe of the same dimensions. However, since its completion, important facts bearing upon the design of the concrete standpipes have been brought out by Mr. Hyram B. Andrews in a paper read by him at a meeting of the Boston Society of Civil Engineers. Had the design been carried out in accordance with his recommendations, the cost would have been nearly as great as for a steel standpipe. A wall thickness of 14 inches was decided upon, as a result of a study of concrete standpipe, previously constructed, this thickness being ample to transmit the stress to the reinforcing steel and to secure imperviousness with the concrete proportions used. The working stress assumed for the steel was 16,000 pounds per square inch. No mechanical bond was used to fasten the bars to each other. They were lapped 36 inches and bound in position with wire. Laps in adjacent rings were not allowed to come in the same vertical line.

When next designing a reinforced standpipe, it is the writer's intention to follow closely the lines laid down by Mr. Andrews in the paper mentioned above, the most important of which are briefly as follows: (1) The use of a very rich mixture of concrete; (2) a thickness of wall sufficient of itself to prevent the rupture of the concrete when the standpipe is full, (3) vertical reinforcement between the base and walls to distribute the bending moment and shearing stress, (4) a steel dam at each horizontal joint, in addition to the usual "keyings" to prevent seepage.

It is of fundamental importance that a standpipe designed and constructed on the assumption that the tensile stress is to be carried by the concrete alone with the reinforcing bars added as a guaranty of safety, should be allowed to stand at least 60 days after completion before being filled so that the concrete can secure its full tensile strength.

The ornamental cornice and other decorative work at the top and base of the standpipe were added to relieve the severe lines of the structure, as the standpipe occupies the crest of the highest hill in the vicinity and can be seen for many miles. As may be seen from the photograph, it has a much more dignified and interesting appearance than a plain cylinder of steel. No manhole is provided in the wall near the base as in a steel standpipe, as the construction difficulties of furnishing such an opening are hard to overcome for a concrete standpipe. The 8-inch inlet pipe is brought up through the bottom for the same reason.

Construction Equipment.—The steel forms for the outside of the standpipe were made from the drawing shown in Fig. 2. Two complete rings were used in order that one might be assembled on top of the other without waiting for the concrete to acquire a hard set and to secure a better bond at the joints by pouring fresh concrete on that still "green." The cost of these forms delivered at Belton was $423.

The concrete was mixed in a 3-cubic-foot batch Smith hand mixer, which discharged into a steel elevator bucket of the same capacity, arranged to run in vertical guides and to dump automatically into a combined bin and chute set above the working platform. The bucket was hoisted by a team, used for other purposes when the pouring was not in progress. The wheelbarrows used in placing the concrete were

filled by opening a wooden gate at the lower end of the bin. The outside scaffolding was made of 3-inch by 10-inch discarded bridge flooring cross braced with 1-inch by 8-inch ship lap. It was erected in sections as the work progressed.

The inside working platform was supported on double rows of 3-inch by 8-inch joists projecting radially from a

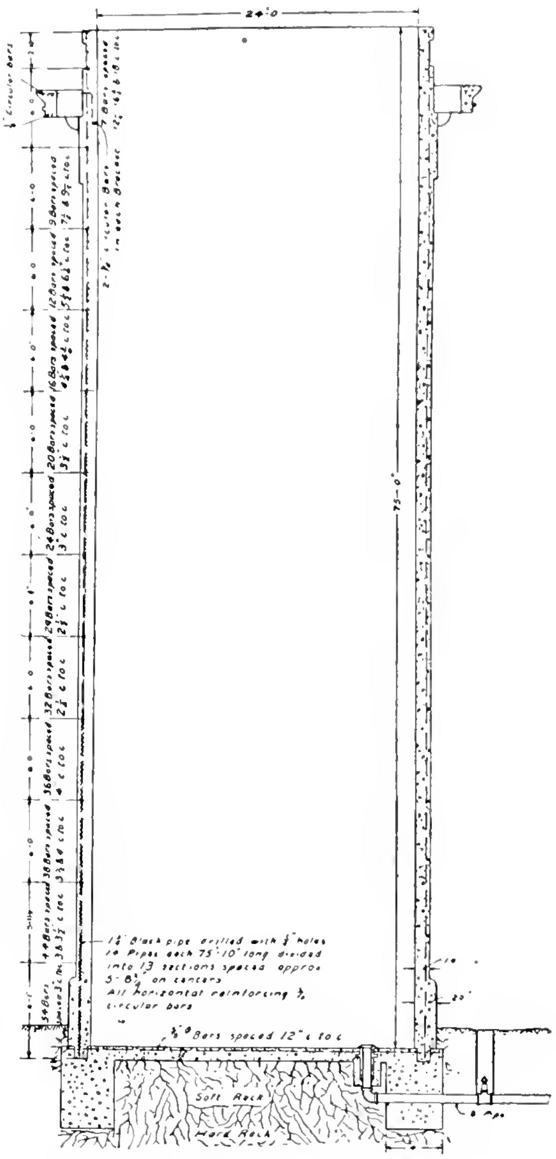


Fig. 1.—Vertical Section of Standpipe.

short central post to which they were rigidly attached. Each pair of floor joists was separated by wooden blocks allowing the 4-inch by 4-inch vertical guide and support studs to pass between them. These studs were set back 2½ feet from the inside of the wall to give room for the wheelbarrows. The only inside flooring was that laid between these studs and the wall. The stud joints were mitered and fastened with bolts. Six feet below the working platform a similar arrangement of joists supported the wooden inside forms, which were made up in sections 6 feet high, or double that of a single set of outside forms. Each of these systems of floor joists was supported by iron pins set in holes bored in the vertical studs at any level required.

Method of Construction.—Excavation for the foundation revealed rather soft rock at the depth originally determined upon for the bottom of the standpipe and wall footings. The excavations for the wall footings was therefore deepened four feet, stopping on solid rock. The concrete for the wall foundation was poured to within about one foot of the lower side of the bottom of the standpipe. The remainder of the wall foundation and the bottom were next placed at one pouring. Keys were left for the walls, as shown in Fig. 1. During this pouring, one-foot lengths of 1¼-inch pipe, threaded on the upper end and provided with sleeves, were set vertically around the periphery in the soft concrete.

The steel forms shown in Fig. 2 were used for the outside of the thicker wall at the base as well as for the remainder of the vertical shell. The increase in the circumference required for the first 6 feet from the bottom was obtained by bolting the plates in each ring against vertical wood spreaders.

The 1¼-inch pipes used for supports for the reinforcing bars came upon the ground cut into sections of the exact length shown in Fig. 1, threaded and drilled. Each 6-foot section was screwed into place as it was reached with the concrete.

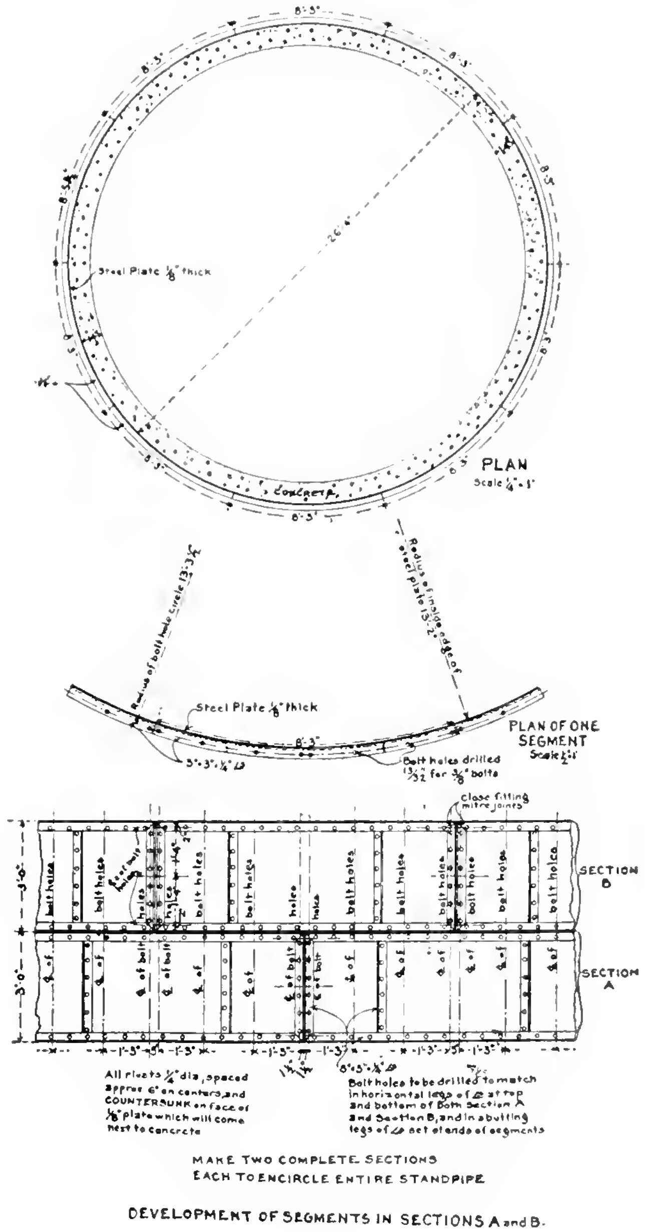


Fig. 2.

The reinforcing bars were bent to the approximate curvature required before hoisting them to position. At each vertical pipe each bar was spaced and held by passing a wire through the ¼-inch holes in the pipe and around the

bar. When the work on the walls was first started, only one three-foot section of concrete could be poured in two days on account of the large amount of reinforcing steel which had to be placed. After a height of 24 feet was reached a three-foot section was poured each day. When the pouring of a secton once started, it was finished regardless of the time required, the work frequently running well into the night on account of the difficulties encountered in raising the inside platform. Each pouring of a three-foot section required about three hours, 9 cubic yards of concrete being placed in that time. The concrete was mixed soft but not sloppy and was distributed in wheelbarrows in layers 12 inches thick, care being taken to equalize the pressure against the forms by uniform distribution. As soon as each pouring of a three-foot section was finished large V-shaped wooden keys were placed in the soft concrete. Before the pouring of another section was begun these keys were removed, the whole exposed surface of the concrete was wire brushed and washed, and the space occupied by the key filled to overflowing with 1:2 mortar.

As soon as the inside forms for each 6-foot section were removed, the inside wall was thoroughly wet and painted with a thick, neat cement grout.

Since the centre of the standpipe was occupied by the joint produced by the abutting radial floor joists, the walls were kept vertical by a centre secured through the use of a 30-inch wooden circular disk the exact size of a circle drawn upon and concentric with the concrete bottom of the standpipe. Three corresponding points 120 degrees apart were set on the disk and circle. The disk was then set in approximate position and adjusted accurately by shifting until plumb bobs dropped from the three points were directly above the corresponding points on the circle below. In order to dampen the plumb bob swing without hiding the three points on the floor circle, glass tumblers filled with water were placed over them.

The entire cornice and brackets are monolithic. The forms for this part of the work were supported on the tops of the outside verticals which were cut off at the proper height for this purpose. The tablets below the cornice were moulded on the ground, hoisted to position, and grouted into recesses left in the wall.

The construction force consisted of 1 foreman, 1 carpenter with 2 helpers, 1 driver with team, and 7 laborers. After the completion of the standpipe the outside was scraped, washed and painted with cement grout mixed with sufficient sand to make it spread readily. When the standpipe was first filled some leakage occurred, due to the development of fine vertical cracks in the concrete as the steel elongated under its working stress. This leakage has gradually decreased, until at present it is an immeasurable quantity. The total cost of the standpipe was $6,000, $500 of which amount was spent upon the cornice and ornamental work.

Concrete.—The gravel and sand used for the concrete occur mixed in the same bank which is located about two miles from the standpipe. The sand varies from rather fine to coarse. In order to secure as dense a concrete as possible for the amount of cement used, sufficient fine sand from a sand pocket in the gravel pit was added to fill the voids in the unscreened mixture of combined gravel and sand. Cement was then added to the proportions of 1 part of cement to 6.33 parts of the aggregate, the entire proportion being as follows: 1 part cement, 2.4 parts coarse sand, 3.6 parts gravel, 0.33 parts fine sand. All gravel and sand particles passing through a ⅜-inch mesh inclined screen were classed as coarse sand. The resulting concrete was very rich in appearance. Cut into some time after the erection of the standpipe, it was found to be hard and dense.

AMERICAN SOCIETY OF CIVIL ENGINEERS TO HOLD SUMMER MEETING AT OTTAWA.

It will doubtless interest a great many of our readers to know that the American Society of Civil Engineers intends to hold their summer convention at Ottawa from June 17th to 20th, inclusive. The headquarters of the convention will be Chateau Laurier. Members of the Canadian Society of Civil Engineers will be delighted to hear of this, and in all probability many of them will take advantage of this opportunity of meeting with fellow-engineers from across the border.

The American Society of Civil Engineers has its headquarters at 220 West 57th Street, New York, the secretary being Charles Warren Hunt, whom, we understand, has held that office since 1895. The society has approximately a total membership of 6,380, of which number about 160 are resident in Canada, located as follows:—

MEMBERS.—Almonte, Ont.—A. Bell. **Amherstburg, Ont.**—C. Y. Dixon, H. Hodgman. **Barrie, Ont.**—F. Moberly. **Brandon, Man.**—R. E. Speakman. **Calgary, Alta.**—H. B. Muckleston. **Chicoutimi, Que.**—J. W. Richardson. **Cochrane, Ont.**—A. T. Tomlinson. **Cornwall, Ont.**—C. D. Sargent. **Dawson, Y.T.**—C. A. Thomas. **Edmonton, Alta.**—J. Callaghan. **Hamilton, Ont.**—J. Hobson, R. M. Roy. **Lachine, Que.**—V. K. Spicer. **Medicine Hat, Alta.**—A. M. Grace. **Moncton, N.B.**—P. S. Archibald. **Montreal, Que.**—W. I. Bishop, W. L. Browne, G. H. Duggan, E. G. Evans, F. E. Field, W. J. Francis, A. S. Going, F. P. Gutelius, G. R. Heckle, H. Holgate, H. S. Holt, J. A. Jamieson, P. Johnson, H. G. Kelley, J. Kennedy, R. B. Kenrick, R. S. Lea, H. M. MacKay, W. McNab, J. Mayer, P. A. Peterson, A. W. Robinson, J. Ross, J. M. Shanly, F. P. Shearwood. **Moose Jaw, Sask.**—L. W. Rundlett. **Nemegos, Ont.**—L. F. McCoy. **New Westminster, B.C.**—A. C. Eddy. **North Temiskaming, Que.**—G. B. Hull. **Ottawa, Ont.**—S. J. Chapleau, C. R. F. Coutlee, A. R. Dufresne, S. Fleming, C. H. Keefer, T. C. Keefer, J. L. P. O'Hanly. **Saint John, N.B.**—J. K. Scammell. **Sault Ste. Marie, Ont.**—R. S. McCormick. **Sydney, N.S.**—M. J. Butler. **Toronto, Ont.**—W. H. Breithaupt, W. Chipman, E. H. Keating, C. H. Mithell, C. H. Rust, C. B. Smith, W. F. Tye. **Vancouver, B.C.**—G. R. G. Conway, R. F. Hayward, J. H. Kennedy, G. A. McCarthy, O. Shanks, C. B. Vorce, W. C. Weeks. **Vernon, B.C.**—F. R. Johnson. **Victoria, B.C.**—F. C. Gamble, H. Hartwell, E. Mohun. **Walkerville, Ont.**—W. Pope. **Winnipeg, Man.**—E. E. Brydone-Jack, A. C. Dennis, W. A. James, F. Lee, H. N. Ruttan, J. G. Sullivan.

ASSOCIATE MEMBERS.—Bassano, Alta.—H. Sidenius. **Calgary, Alta.**—T. M. Fysbe, F. H. Peters, G. A. Wall. **Duncans, B.C.**—B. B. Boyd. **Dunnville, Ont.**—W. F. Scott. **Halifax, N.S.**—A. Adams, J. W. Roland. **Hawkesbury, Ont.**—J. R. de Gratresse. **Hydraulic, B.C.**—W. W. Edwards. **Lethbridge, Alta.**—A. C. D. Blanchard. **Lytton, B.C.**—J. V. Nimmo. **Montreal, Que.**—C. J. Armstrong, C. B. Brown, Jr., L. N. Edwards, J. A. Grant, C. E. Gudewill, R. E. Hunter, G. S. Miller, C. M. Morssen, B. Ripley, C. L. Slocum, A. J. Wills. **Niagara Falls, Ont.**—K. F. Cooper. **Ottawa, Ont.**—D. W. McLachlan, E. H. Pense, J. Taylor. **Outlook, Sask.**—J. R. C. Macredie. **Pearl, Ont.**—C. D. Ashbrook. **Port Arthur, Ont.**—D. A. Daly, L. Móller. **Prince Rupert, B.C.**—W. H. Ferguson. **Princeton, B.C.**—M. E. Brooks, C. N. Kast. **Red Deer, Alta.**—J. G. MacGregor. **St. Boniface, Man.**—McC. P. Blair. **Saint John, N.B.**—A M. Bouillon. **St. Thomas, Ont.**—G. H. Harris. **Saskatoon, Sask.**—E. B. L. Unger. **Shawinigan Falls, Que.**—P. H. Falter, G. P. Hawley. **Strathmore, Alta.**—R. S. Stockton. **Suffield, Alta.**—A. H. Ayers, E. Montgomery. **Toronto, Ont.**—F. F. Longley, C. W. Noble, G. F. F. Osborne, J. H. Shortt. **Vancouver, B.C.**—J. R. Grant, H. S. Hancock, Jr., C. A. Lee, T. P. Moorehead, C. P. Moss. **Victoria, B.C.**—

C. Hoard, H. S. Nichol. **Winnipeg, Man.**—J. H. Alexander, T. J. S. Edelen, H. Edwards, J. D. Matheson, E. L. Mosley.

ASSOCIATES.—Montreal, Que.—A. Chaussé, T. J. Drummond. **Toronto, Ont.**—C. E. Goad.

JUNIORS.—Duncans, B.C.—H. M. Hadley. **Halifax, N.S.**—C. D. Howe. **Jonquieres, Que.**—W. W. Wilson. **Montreal, Que.**—R. DeL. French. **Saskatoon, Sask.**—R. J. Schmid. **Sherbrooke, Que.**—K. M. Cameron. **Smith's Falls, Ont.**—L. W. Klingner. **Toronto, Ont.**—E. W. Hyde, Jr., G. W. C. Lightner. **Vancouver, B.C.**—M. C. Burr, H. F. Forsyth, L. R. Hjorth, W. H. Jones, T. E. Price. **Walkerville, Ont.**—R. B. Leete. **Westmount, Que.**—T. Leach.

The president of the society this year is Geo. F. Swain, Professor of Civil Engineering, Harvard University.

PULVERIZED COAL.

The use of coal that has been pulverized as a fuel, and the economic value of same, is interestingly described in a paper by Mr. H. R. Barnhurst, published in a recent issue of Metallurgical and Chemical Engineering. He states that the requirements necessary to success, while simple, are absolute and must be obeyed.

First—The coal must be dried so that it contains not over 1 per cent. of moisture.

Second—The coal must be pulverized to a high degree of fineness.

Third—It must be projected into a chamber hot enough to cause instant deflagration.

Fourth—It must be supplied with air sufficient to yield the oxygen necessary to burn the carbon of the coal at once to CO_2.

Taking up these requirements in order, the drying of the coal to a moisture content of not over 1 per cent. is indispensable. Coal does not grind well if moisture in excess of this be present.

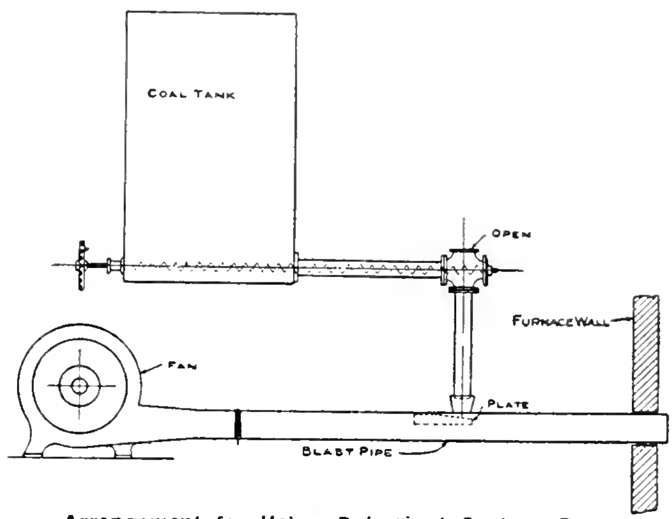
In burning coal the moisture, free or combined, must be disposed of either in the process of preparation or in the moment of combustion. In the latter case not only is the efficiency of the furnace lowered by the calorific investment in the superheated steam passing out as a product, but the temperature of the furnace is lowered materially. The drying of wet coal in the furnace itself, is doing this necessary part of the work in the most expensive place and at the cost of temperatures which may be essential to the industrial process of which high heat is a factor.

Fine grinding—With the best type of machines obtainable for this purpose, the coal and its contained impurities may readily be powdered to such a degree that under the screen tests 85 to 90 per cent. will pass through apertures 1/400 in. square, while the total residuum left upon a screen whose apertures are 1/200 in. square, will be from 2½ to 5 per cent. and this residuum would pass through screens of 1/100 in. square. It must, however, be borne in mind that of the percentage passing the smaller apertures 1/400 in. square there is a high percentage of absolute dust or impalpable powder not commercially measurable. This is proven by the fact that in tests made upon calibrated screens of 1/600 in. square apertures, over 70 per cent. still passed through. It certainly appears to be safe to assume, therefore, that the average size of the particles would be below a cube measuring 1/600 in. on the side.

It may be interesting, therefore, to state that the total numbers of particles resulting from the powdering of 1 cubic inch of coal to the dimensions given would yield 216,000,000 grains of dust. Simple calculation on this basis shows that while a cubic inch of coal exposes 6 square inches for the absorption and liberation of heat, the surface exposed for the same purposes by the powdered coal is 25 square feet. Inasmuch as no fuel burns until it is heated to a temperature at which it developes more heat than it receives, the advantage of this enormous absorbing and delivering surface is apparent. The result of this is shown in the clearness and uniformity of the flame produced. Where coarse particles are permitted to enter the furnace, the distinct sparkles are apparent. These larger particles are carried beyond the region of oxygen supply and are for this reason not fully burned.

Third—While coal ignites freely, in a hot chamber, this ignition means the absorption of heat from somewhere, and if the coal rapidly projected by air does not develop its heat near the point of ignition, means must be devised to maintain the heat necessary for ignition where it is needed, i.e., at the first entrance of the coal into the furnace. It is apparent, therefore, that giving the fuel too great velocity upon entrance is not good practice.

Considering the fourth requirement along with the third we would say that some singular errors and misconceptions have attended the practices of many users of powdered coal. More particularly do we refer to the use of large fans to supply the air necessary for the projection of the fuel, where the air nozzle has been reduced from 16 in. or 18 in. diameter to 4 or 5 in. at the jet under the expectation that all of the air in the 16-in. or 18-in. pipe would be hurried through the 4 or 5-in. nozzle if not a smaller one. The futility of this is apparent.



Arrangement for Using Pulverized Coal as Fuel.

To describe the operation more clearly, the coal is received in a bin over the feeders. (Fig. 1). Its weight is about 38 lb. per cubic foot when loose in the bin. Settling awhile brings the weight to about 45 lb. per cubic foot by displacing the entrained air. Across the bottom of this bin and within a pipe extending horizontally from it is a double-flight worm or feed screw. This double-flight screw resists the tendency of the light coal to flow of itself along the feed pipe. This screw extends over a flanged pipe-cross into which the fuel is delivered. The rear end of the screw is supported by a bearing in a flange on the side of the bin near the bottom, the shaft projecting to receive a driving pulley or chain sprocket. The delivery end of the screw shaft is supported by a bearing in the cover of the horizontal opening of the flanged pipe-cross. The top opening of the cross is uncovered to permit the air to draw down with the falling fuel. This fuel dispersed in the air so drawn in, de-

scends a vertical pipe attached to the lower opening of the cross, the pipe being long enough to be within the funnel or injection pipe. At the bottom of the funnel is a diagonal plate upon which the fuel falls. The plate is tight against the air pipe up the current and flared open on the side, towards the furnace down the current and takes up about one-fourth the diameter of the pipe. This forms at this point a "vena contracta" producing a suction in the funnel, draw-drawing in through it, supplementary air with the fuel. The fuel spraying upon this plate mixes very thoroughly with the air from the fan, the eddy currents caused by it, assisting very materially its dispersal through the main column of air supplied by the fan.

The admission funnel should be far enough from the furnace to permit this mixture to be thorough. Too high pressures defeat this somewhat, as well as tending to project the fuel too far into the furnace before flashing. As soon as this fuel cloud begins to absorb the heat of the chamber into which it passes, a rapid expansion of the air takes place, separating the particles of fuel in suspension, in the proportions of the absolute temperatures to the temperature of the initial air. It is a matter of discussion whether the best results are obtainable by a delivery of all the air found necessary for combustion by the free pipe together with the percentage of excess air found to produce the best results, or to use a smaller quantity of air in the feed pipe and look for the further supply from other openings.

Good practice would seem to point to absolute control of air by the fan and its gates, and the fuel by the varied speed of the feed screw. The furnace should have a good natural draft to a chimney controlled by a damper. It must be remembered that perfect combustion of one pound of carbon demands 2⅔ pounds of oxygen. This is contained in 11.6 pounds of air or about 154 cubic feet; should less than this be supplied a proportionate amount of fuel will be burned to CO with a loss of two-thirds of its initial efficiency, a part of which may be regained by contact with heated oxygen, or it may pass on and burn in the chimney, doing no good if the heated oxygen is brought there in first contact with it. If the oxygen is not heated sufficiently smoke will result and the full heat be undeveloped.

The greater the volatile constituents of the coal the more readily will it deflagrate, as these gases distil from the fuel and ignite at a temperature lower than that required for the carbon itself. Their need for oxygen is, however, greater per pound of fuel (or gases) than that of carbon, and is proportional to the heat evolved. Their average value is in heat units nearly 50 per cent. more than that of carbon.

The temperatures attainable with pulverized coal are very high, so high that excess air is commonly admitted in proportions ranging between 50 and 100 per cent. This will be shown by the following table based upon the perfect theoretical combustion of carbon with proportion of air given:—

1 lb. carbon with 11.6 lb. air...Normal.	4859° F
1 lb. carbon with 12.76 lb. air...10 per cent. excess.	4448° F
1 lb. carbon with 13.92 lb. air...20 per cent. excess.	4102° F.
1 lb. carbon with 15.08 lb. air...30 per cent. excess.	3807° F.
1 lb. carbon with 16.24 lb. air...40 per cent. excess.	3550° F
1 lb. carbon with 17.40 lb. air...50 per cent. excess.	3326° F.
1 lb. carbon with 18.56 lb. air...60 per cent. excess.	3129° F.
1 lb. carbon with 19.72 lb. air...70 per cent. excess.	2954° F
1 lb. carbon with 20.88 lb. air...80 per cent. excess.	2797° F.
1 lb. carbon with 22.04 lb. air...90 per cent. excess.	2656° F.
1 lb. carbon with 23.20 lb. air..100 per cent. excess.	2529° F.

In practice the furnace tender speedily becomes educated to the point of judging whether a fire is hot enough by its color and by the length of the flame. The more perfect the conditions the shorter and whiter the flame will be.

The pulverized coal introduces very effectively the element of time into the equation. Given a pound of fuel with, say 15,000 heat units, these may all be developed by slow combustion at low temperature, or by burning the fuel in pulverized form, quick combustion gives high temperature. The same quantity of heat developed in both cases, but in one instance in a minute and in the other half an hour.

The influence of preheated air upon the economy of the burning of any fuel resolves itself into ascertaining the quantity of fuel which would be necessary to bring the air to the preheated temperature plus the heating of the excess air also to that temperature. Except as a means of transporting heat, excess air has no effect in furnace as far as the fuel combustion is affected. This preheating, to be of any economical value, must be obtained from heat which would else be wasted. To heat all the primary air necessary to combustion and 50 per cent. excess air to a temperature of 1,000 degrees in excess of the surrounding temperatures would show a saving of some 4,100 heat units or nearly 30 per cent. of the fuel value. But few of the industries, however, outside of the metallurgical arts permit the waste heat to pass off at such temperatures and volume as to be available. The regenerative checker-work of open-hearth steel furnaces is the best example of success in this preheating.

In this case it has been a necessity to boost the temperature in this way, because the gases from gas products burned cold, would not give the temperatures necessary for the work to be done.

We may say that four heat units per degree would represent the saving achieved per pound of fuel fired with 50 per cent. excess air by heating all the air admitted to the furnace. The measure of efficiency is dependent upon the loss finally carried away in the rejected gases. In the case of regenerative furnaces this may be lower than in furnaces not equipped with regenerating checker-work, but if to the percentage of loss with regeneratives be added the losses in the gas producers, the pulverized coal directly fired will afford the greater economy of operation.

With the means at hand of obtaining quickly and safely heat of greater intensity than by the use of coal upon grates or in producers, it would appear to render practicable further steps in many of the arts hitherto restricted by the limitations of furnaces at command.

The fear of explosion of coal need not enter into consideration. Coal lying in a bin or conveyer does not explode. It is only when mixed with air or supported by air currents that coal will "puff." In burning it, therefore, we do not mix the coal and air until just as it enters the furnace at high velocity. Against this column of inrushing air and coal the puff cannot take place.

The air is introduced before the coal is turned on, and the coal is shut off before the air. Only by introducing coal faster than it can burn will an explosion occur and then the effect is trifling. It is the gas produced and not the coal that causes this. It wants oxygen and comes outside to get it.

The presence of impurities in the fuel has not much effect. Of course, only combustibles will burn; the incombustibles are inert and do not affect the operation of the furnace. Their effect is in the lessened results from a dollar's worth of fuel negatived by a goodly percentage of waste substance. The writer has burned effectively fuel in which analysis showed 52 per cent. of ash. Let us reiterate the conditions—Dry coal, fine grinding, hot chamber or fire box, proper air supply.

An important part of the subject must not be overlooked. The durability of the future is, of course, vitally essential. In the metallurgical arts when extreme heat is an essential part of the operation, care must be taken to avoid destroying

the furnace by its own operation. This is not difficult. Much of the troubles have come from the gases impinging upon the furnace walls at points where change of direction of gas travel is necessary, and from too high velocity of gases due to contracted ports.

If the utilized heat is largely absorbed from the gases by the charge, the waste gases will be proportionately less active in scouring the brickwork. In almost any construction except perhaps a rotary kiln it is found necessary to change the direction of the gases in their progress toward the flue. This change of direction causes the gases to impunge upon the diverting bricks with an energy proportional to their velocity. The brick at these points can be fully protected by a system of water-cooled pipes embedded in the walls. The brick may frit somewhat until the area of protection is reached, when further progress is arrested.

The surprisingly small amount of water which it has been found necessary to introduce, maintaining the outlet below 200° Fahr. proves that the cooling effect is limited to a prevention of cumulative action and is not perceptibly a drawback upon efficiency. Of course, the piping must be so arranged that no air or steam pockets shall exist and that the circulation will be proportional to the heat stimulus. One other point and we will conclude. The pulverized coal furnace has no ups and downs. There is no thick fire or thin fire, fresh coal or old coal to insure fluctuations.

The furnace can be always kept at its best working point and so kept it will be heated equally all over. Of course, a large charge of metal to be heated will by its very volume absorb heat rapidly, causing a fall in waste gas temperature and possibly a little smoke at first. This is in the nature of things, but the extremely effective conditions quickly bring the charge to a point where the chill is not sufficient to affect combustion and high temperatures come again and smoke disappears. If the work to be done is constant, there is no reason why high conditions may not be uniformly maintained by proper construction and operation.

We believe the subject has been mastered to a point beyond the experimental stage where the full benefits of high efficiency may be confidently relied upon in this beautiful method of burning coal. As before mentioned, the quality of the coal is not with this method of supreme importance. Indeed, its great value in the developments of the future may lie in the efficiencies obtainable from low-class or refractory fuels hitherto unavailable.

PROPOSED POWER PLANTS FOR C.M. AND S.P. RAILWAY.

Details of the proposed electrification of the Chicago, Milwaukee and St. Paul Railroad state that there will be 7 stationary power plants, at least, generating electricity by water-power at Great Falls, Helena, Madison River, Big Hole, and Thompson Falls, near the western border of Montana. All these will be connected in parallel, distributing their power to a single reservoir. Electricity will be conveyed to motors by means of a trolley system. Power will be purchased from the producing company, the railroad having nothing to do with construction and installation of power-plants. St. Paul probably will have 50 electric locomotives to begin the service, specially designed to meet the needs of the situation. These must pull a maximum freight tonnage of 2,100 tons up a 1 per cent. grade. On heavy grades helpers will be added. The locomotives will be limited in design to a speed of 30 miles per hour up grade and 25 miles per hour down grade for passenger motors, and 15 miles per hour for freights.

POLARIS OR NORTH STAR.

By E. S. M. Lovelace, M.Can.Soc.C.E.*

To find the azimuth or true astronomical bearing of a line from an observation taken at any time that the above star happens to be visible.

While the data for an observation to determine the true or astronomical bearing of a line can, of course, always be obtained from one of the almanacs published yearly in this and other countries, yet, to apply the methods therein outlined requires at least some knowledge of field astronomy, and unfortunately, as it happens, numerous engineers, having become rusty on the subejct, have neither the time nor the opportunity to go into the matter when suddenly (as it well may) arises the necessity for making such a determination. Possibly, too, at the particular time an almanac may be not available.

For such, therefore, the following short tables, compiled by the writer in connection with his private practice, and requiring as they do for their application, no previous knowledge of astronomical problems whatever, afford an easy method of making a determination. The principal advantage obtained from the use of the tables (as illustrated by the example given below) is that in place of having to sit up to some inconvenient hour, (waiting, say, for the greatest elongation of the polar star) only, as frequently happens, to find that at the particular moment nothing can be seen, the observation may be made at any convenient time that the star happens to be visible. This is an advantage that at least the men at the instrument will appreciate.

The tables are worked out for the next four years and cover the northern latitudes between 40 and 52 degrees.

Standard time is the local mean time at certain standard meridians west of Greenwich; these standard meridians of longitude corresponding to the various standard times in use in Canada are given in Table III.

t, the hour angle of north star at time of observation T is given by

$$t = T + \Delta T + \Delta' \qquad (1)$$

where T is the standard time of the observation

where ΔT is the correction (four minutes per degree) for difference in longitude between the place of observation and the standard meridian to which T is referred.

where $\Delta' = 3.94$ (D-E) minutes

D being the given date and time of observation expressed decimally to the nearest tenth of a day and E is the constant for the year given in Table I.

Knowing the (approximate) latitude of the place of observation and t, then A the azimuth of north star at time of observation T is given by

$$A = \pm F, \text{ a minutes} \qquad (2)$$

where F and a respectively are interpolated from Tables I. and II., the + sign indicating that the north star is east of true north, the — sign indicating that the north star is west of true north.

T, standard time shown by watch, need only be within three or four minutes of being correct.

ΔT is the correction to the standard time in order to reduce it to local time, this correction corresponding to the difference in longitude between the meridian of the place of observation and the meridian to which the particular standard time shown by the watch is referred. Knowing, therefore, the standard time (whether Atlantic, Eastern, etc.) which the watch is showing, in order to

* Civil and Consulting Engineer, Montreal.

get the correction ΔT it is only necessary to take the difference in degrees between the corresponding longitude given in Table III. and the longitude (approximate only) at the place of observation, for this difference in degrees multiplied by four gives the correction ΔT in minutes.

The correction ΔT is, of course, to be added when the place of observation is to the east of one of the above standard meridians and subtracted when it is to the west of such standard meridian.

In getting $\Delta' = 3.94$ (D-E) minutes, it should be remembered that the astronomical day begins at noon and the hours are numbered consecutively from 0 to 24, while the civil day begins at midnight and the hours are numbered from 0 to 12 a.m. then repeated p.m., thus, civil time August 7th 3h a.m. equals astronomical time August 6th, 15h and D would therefore be August 6.6. In the p.m. hours the dates agree.

Table I.

	1913	1914	1915	1916
	E	E	E	E
	April 14.0	April 14.4	April 14.7	April 14.1
Latitude.	F	F	F	F
40°	0.95	0.94	0.94	0.94
41°	0.97	0.96	0.96	0.95
42°	0.98	0.98	0.98	0.97
43°	1.00	1.00	0.99	0.99
44°	1.02	1.01	1.01	1.01
45°	1.04	1.03	1.03	1.02
46°	1.05	1.05	1.05	1.04
47°	1.07	1.07	1.06	1.06
48°	1.09	1.09	1.08	1.08
49°	1.11	1.10	1.10	1.09
50°	1.13	1.12	1.12	1.11
51°	1.15	1.15	1.14	1.14
52°	1.18	1.18	1.17	1.17

Table II.

Hour Angle t	a	Hour Angle t	a
0 hours	— 0 minutes	13 hours	+24 minutes
1 "	—25 "	14 "	+47 "
2 "	—49 "	15 "	+67 "
3 "	—69 "	16 "	+82 "
4 "	—84 "	17 "	+92 "
5 "	—93 "	18 "	+96 "
6 "	—96 "	19 "	+93 "
7 "	—92 "	20 "	+84 "
8 "	—82 "	21 "	+69 "
9 "	—67 "	22 "	+49 "
10 "	—47 "	23 "	+25 "
11 "	—24 "	24 "	+ 0 "
12 "	— 0 "		

Table III.

Standard Time.	Longitude West of Greenwich.
Atlantic standard	60°
Eastern standard	75°
Central standard	90°
Mountain standard	105°
Pacific standard	120°

Example.—Suppose an observation is to be made at Baie St. Paul, County of Charlevoix, Province of Quebec, in 1913. By inspection of a map it can be seen that approximately the latitude of this place is 47° 30′ and the longitude 70° 30′. Say, on August 7th at 8h 22m p.m., eastern standard time, an observation of Polaris is taken: The correction corresponding to one degree of longitude is four minutes.

$\therefore \Delta T = (75° - 70\tfrac{1}{2}°)\ 4 = +\ 18$ minutes

D = August 7.3 and from Table I., E = April 14.0

$\therefore \Delta' = 3.94$ (difference in days between August 7.3 and April 14.0) $= 3.94 \times 115.3 = 454^m = 7^h\ 34^m$

By (1) $t = T + \Delta T + \Delta' =$ 8h 22m + 0h 18m + 7h 34m = 16h 14m.

Interpolating from Tables I. and II.

F corresponding to latitude 47° 30′ is 1.08

a corresponding to hour angle 16h 14m is +84′

$\therefore$ azimuth of Polaris at 8h 22m p.m. is from (2)

$$A = F \times a = 1.08 \times 84 = +\ 91' = 1°\ 31'$$

That is, at 8h 22m p.m. on August 7th, 1913, the Pole star will be 1° 31′ to the east of the true or astronomical north, and from this the true bearing can be ascertained of any line taken in connection with the observation of the star.

GASKETS AND STEAM.

One could easily write fifty-seven varieties of sermons about gaskets, poor packing, and the steam waste incident thereto, but this is not to be one of the regular fifty-seven varieties; it is to be a new and different one. There is many an instance when emergency, and a species of genius, have led a man, back in the woods, into taking his shirt-tail to make a gasket for a cylinder-head. And while this is often a poor and reckless makeshift, it is really better in effect than are some of the uses of thick gaskets where men think they have prepared and are doing the right thing. In the modern steam-engine the clearance space at the ends of the cylinder has been reduced to a point of small fractions, and even the added fraction of an unnecessarily thick gasket may cause useless waste of steam. Some of the old-style engines may be found yet in the rural districts that will show a clearance of an inch between the cylinder-head and the piston at the end of the stroke. And, strange to say, with this staring them in the face, it seems difficult for some to understand why a new engine of the same size will do more work and use less steam when the general construction is the same. In other words, there are some who do not seem to have realized that it takes steam to fill extra space in a cylinder, just the same as it takes steam to drive the engine—and it's the same kind of steam, too. To the class who are thus thick-headed belongs the engineer who puts gaskets an eighth of an inch thick under the cylinder-head simply because he has material of that kind in stock. He might better emulate the back-woodsman in emergencies and use a piece of his shirt-tail. Fortunately, there are not many of this class, even in the backwoods, but as long as the few remain it is in order to point out that all unnecessary space at the end of a steam cylinder calls for the expenditure of unnecessary steam power.—J. Crow Taylor in The National Engineer.

Greater Montreal will erect during the present year forty million dollars' worth of buildings according to the estimate of Mr. R. L. Wherry, secretary of the Builders' Exchange. Last year the figures were $33,080,000.

The Russian Ministry of Ways of Communication has decided to make an investigation in regard to the projected line from Saratov to Novotcherkask. This line would be 400 miles long, would traverse the grain territories of the Don Cossacks territory, and would be of great importance in connection with the future South Siberian Railway, as it would create a direct transit route to the Black Sea for the Siberian agricultural products.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, MARCH 27, 1913. No. 13.

CONTENTS OF THIS ISSUE.

THE STUDY OF STREAM-FLOW DATA.

The increasing utilization of the water-powers of the country emphasize the necessity for the more thorough compilation and recording of stream-flow records.

It is a fact that the engineering schools in Canada, and also in the United States, have not devoted as much attention to this branch of the profession as the importance of the subject deserves. The elementary principles necessary for the intelligent design of most engineering structures and an introduction to the different basic subjects which lie at the foundation of the several branches are well covered in our technical colleges. This is not true, however, of the courses in hydraulic engineering in at least some of its phases. Professor Mead in a recent paper before the Cornell Society of Civil Engineers, in drawing attention to the above fact, states that experience has demonstrated the fact that more failures have resulted in various projects of hydraulic engineering from a lack of an adequate conception on the part of the designing engineer of the fundamental principles of hydrology, or of the importance of the hydrological factors, than from defects in the design of construction of the various structures involved. In many cases the engineer has not possessed sufficient knowledge to appreciate the necessity for hydrological investigation and study, and very frequently has ignorantly made unwarranted assumptions and neglected any investigation whatsoever, from a lack of such appreciation.

The results of this lack of appreciation are apparent to every engineer who stops to think over the record of past failures, even here in Canada: water-power plants constructed on streams without sufficient available flows, or with such irregular flows as to make the projects entire or practical failures; spillways and gates in dams constructed with inadequate capacities for the passage of extreme floods; pumping stations constructed to utilize supplies of water which are too limited for the purpose for which they were intended, or with supplies polluted or otherwise undesirable; industries built in locations subject to serious overflow and unnecessary land damage; protecting works built with no adequate idea of the maximum necessities of the case or their effect on flood heights. While in a few isolated cases failures have been due to the fact that adequate stream flow records have been impossible to obtain, and the engineer, relying on his judgment, has been in error, in most cases the failures are due to an absolute lack of knowledge of hydrological principles.

The fundamental cause for this neglect in analyzing the conditions on which every sound hydraulic project must rest is due in great part to the lack of training in our engineering colleges. This same lack of training is apparent in other parts of the hydraulic engineering courses.

The use of electric power generated from waterfalls has increased, because it has been possible to develop and compete with electric power developed by steam. To compete successfully with the steam engine it is necessary that there should be close speed regulation of hydro-electric plants. This has been easy to secure in past developments, due to the fact that the easier types of plants have been installed first; that is, plants with open canal or short penstock. With the increase in the length of penstocks and the use of long feeder conduits, speed regulation becomes an important factor. Yet to-day very few, if any, of our engineering colleges are giving any training along this line, or are even drawing attention to the necessity for study of such conditions. As a result, plants are being installed which, from the standpoint of regulation, are failures.

The colleges must soon realize their responsibility to the hydraulic engineering student. Courses must be remodelled to give the needed instruction if the list of failures in hydraulic design is to be curtailed.

PUBLIC CARRIERS versus THE PUBLIC.

Paralleling the rapid growth of the cities of this continent, in population and suburban area, are the steady and popular demands of civic governments upon city tramway companies for extension of lines, new methods of business, and increased rolling stock. There is no doubt or question of the necessity and need of this twin growth of tramway accommodation, on either the tramway's part or the civic, but there is almost invariably a considerable difference of opinion about the effectiveness and sufficiency of the means adopted by the street railways to keep abreast of the times. It has resulted in considerable antagonism on the part of the people, upon any refusal of public carriers to carry out improvements, especially if the carriers appear to be making money and growing rich. Many people, while believing in the efficiency of company management, and preferring it if the companies can be prevented from waxing unduly rich, yet do not know how they are to be checked from so becoming, and are ready to threaten them with non-extension of franchise in the meantime. Street railways, with their usual comparatively short franchises, are particularly subject to the people, and one would expect would be likely to quickly carry into effect any reasonable civic wishes which did not entirely besmirch their financial horizon.

It seems "riches" and "what is a fair profit" are relative terms, depending on individualism. There have been protestations on the part of public carriers that they were being unjustly adjudged of their wealth and unfairly pressed by the public to the point where they would have to cease doing business. This is of special interest to the engineer, not only in a general way, but because it may open up a new field whereby boards composed of either high-class financial engineers, or possibly engineers and financiers, will be called in to adjudicate between the people and public carriers as to "what are fair demands" to be made upon the latter.

The first big step in this direction is seen in the bill passed in March by the United States Government, whereby a gigantic investigation of the valuation of the property of common carriers and the securing of information concerning their claims, bonds and other securities, has been set on foot. The Interstate Commerce Commission, which has charge, may appreciate the situation and create (it has been recommended to do so) a board composed of nine members, three to be selected by the Interstate Commerce Commission, three by the American Railway Association, and one each by the army, the navy and the American Society of Civil Engineers. This would provide for a non-partisan, impartial and authoritative body, the conclusions of which would be final.

The immediate effect upon the carriers will be the preparation of a complete valuation of all railroad property, entailing an expense of $3,000,000 to $5,000,000 to the carriers alone. After the railways submit the data it will be necessary for the Interstate Commerce Commission, through its experts and assistants, to prepare valuations, and this will cost the government at least $3,000,000 more.

The law provides that the Commission shall make an inventory and classify the physical property as follows: (a) The original cost to date; (b) the cost of reproduction (new); (c) the cost of reproduction less depreciation, and (d) other values and elements of value.

It is not apparent how the Commission will arrive at the original cost to date of railroads which have no records extending back to the origin of the property, and this will be found to be the case with nearly all roads or parts of roads constructed twenty-five years or more ago. The original cost to date is now available from the balance sheet of any railway company under the head of "Cost of Road and Equipment." It will cost the railroads and the government perhaps $2,000,000 to ascertain the original cost to date by the laborious method of investigating original records, and the result may be no more accurate and reliable than the information already at hand.

The United States engineering opinion of the investigation is that the net result of securing the valuation of railroad property will likely prove that the railroads are not over-capitalized, and that as a whole they are not earning a fair return on their cost and present fair value.

A further and interesting viewpoint of a street railway management's idea of present money-making possibilities is seen in the statement of the vice-persident of the Boston Elevated Railway before the Electric Railway Association. He claimed that if the public were not made to understand and become acquainted with the facts of street railway conditions the companies would not be able to continue to do business. The point to be emphasized was the effect of the demands from the public in the way of extensions of lines, increased transfers, etc. In their case these demands have eaten up the advantages which are supposed to come from doing business for a long time in a growing community. This may be seen from the following data: In 1888 some five or six horse railways were put together, forming a consolidated system, which gave the railway company virtually the monopoly of the business of the city. The operations of this consolidated company began substantially on January 1st, 1888.

In the first year there were gross earnings of $4,276,000, and the capital invested was about 2.72 times the amount of these gross earnings. The average number of revenue passengers for the half trip in that year was 22.5, the average length of the half trip was 3.62 miles, and the average distance from the centre of the city to the ends of the routes was 4.79 miles. Following along from that time there was a constant tendency to extend to the more sparsely settled territory, and the lines afterward were extended, not only as to the trips that were run, but as to the total length of the routes. The company began also immediately to electrify the lines, so that in 1892 about half of the system was electrified and the number of revenue passengers per half trip had gone up from 22.5 to 28. Four years later, in 1896, the road was 98 per cent. electrified, and there were 29.5 revenue passengers to the half trip.

Later, the rapid-transit system—that is, the subways and the elevated—was introduced with a view to providing more room for the congested district, and with these lines the demands that were made for service cut down the average revenue passengers per half trip, so that these figures in 1903 went down to 23, and in 1912 were only 25.5. In other words, in 1912, with gross earnings of $16,644,000, only three more revenue passengers to the half trip than with the horse cars in 1888.

These figures are rather significant; what has happened in Boston is probably typical of what will happen in many cities as business increases. Not only will there be more demands for transfers, more demands for ex-

tension in an unprofitable territory, and more demands for new methods of carrying on the business, but in every way the public may take what would be the only increment of the capital invested. The result in Boston has been that the permanent investment has increased to more than six times the gross revenue. It, therefore, appears extremely difficult to carry on business and satisfactorily meet public demands in the United States.

In Canada conditions between the railways and the public are not exactly similar to those in the United States. Nevertheless, there is a sufficiency of resemblance in the attitude of the public mind to make it well worth our while to note and endeavor to profit by the struggles, successes and failures of our neighbors to the south.

OTTAWA'S WATER SUPPLY.*

Writing in a letter to Mayor Ellis, Dr. C. A. Houston suggests that tests of the water of the Gatineau Lake be made by Mr. Joseph Race, the city bacteriologist. The following is an extract of Dr. Houston's letter: "On the assumption that the lake scheme of supply is provisionally adopted, it will be necessary to carry out the prolonged series of bacteriological, chemical and physical investigations as regards the quality of the water in the lake or lakes likely to be chosen for supply purposes. For the engineering part of the work, Sir Alexander Binnie will, no doubt, send out a competent surveyor; for my part, so far as quality is concerned, I have every confidence in the ability of Mr. Race to carry out the work successfully and to furnish me with such results and reports as will enable me ultimately to pronounce judgment in the matter. The bacteriological side of the question is not so important, as, with the gathering ground freed from all human sources of pollution, there is no possibility of the water conveying disease. Physical and chemical tests, on the other hand, are most important, and the water should also be examined for algæ. It will be necessary to collect samples periodically from the lake or lakes likely to be eventually chosen at various spots, and possibly at different depths, and accurate records must be kept of color, hardness, alkalinity, presence or absence of suspended matter, conditions as regards algal growths, temperatures, presence of iron, etc."

* Dr. Houston and Sir Alexander Binnie, the British experts engaged to report on Ottawa's water supply.

FOREST PROTECTION.

A very important conference upon the matter of forest protection along the lines of operating railways in the West has just closed at Winnipeg, the British Columbia Department of Forestry having been represented by Mr. R. H. Benedict, of the headquarters staff, and the parties to the convention being the federal Board of Railway Commissioners, the Province of British Columbia, the Canadian Pacific, the Grand Trunk Pacific, Canadian Northern and Great Northern Railway Companies. General protection of timber along the rights-of-way was the theme of discussion. Last year every mile of right-of-way was inspected by the provincial officers, and the regulations strictly enforced to guarantee the safety of near forests and due payment of royalty for timber cut on Crown lands. The work of inspection is peculiarly onerous in connection with construction operations, and, on the whole, the provincial officers have been well supported by the railway companies. The rule has been laid down that everything cut without permit is considered to constitute a trespass, and where timber is cut, with or without permit, the brush must be properly disposed of without delay.

EXHAUST STEAM AND ITS UTILIZATION AT COLLIERIES AND MINES.

An interesting paper on the above subject was recently presented by J. M. Gordon, at the annual meeting of the Canadian Mining Institute. In the course of his paper Mr. Gordon stated that up to within comparatively recent years the loss of the exhaust steam, and the amount of live steam that was carried down the mine to haulage engines and pumps received scant attention by mining engineers. There was, until recently, no demand for the small sizes of coal from the dry screening plant, and the silt and sludge from the washery; it was argued, therefore, that it was just as well to burn the small sizes in the boilers, than to dump it in a corner of the colliery yard where it would be in the way and an eyesore. Conditions have now changed. This silt, sludge, culm and buckwheat is no longer valueless. Coking plants, briquetting plants and mechanical stokers must now be fed, while competition and the steady increase in working expenses have made the problem of power distribution in and around mines one of considerable importance. To-day more than ever, the law of the survival of the fittest applies. It is the day of the electrical unit. Thus in many of the more advanced mines in Great Britain and on the Continent, we no longer find those huge old Cornish pumps, grinding and groaning as if in agony; no longer thousands of thermal units going to waste as a result of conducting steam pipes down deep and wet shafts to haulages; no longer long transmission lines of compressed air under ground to distant coal cutters. The day for these has passed. In their place we find high lift centrifugal pumps driven at from 1,500 to 2,000 revolutions per minute; three-phase high-tension armored cables passing down the shaft; and the transformation of the current near the distant coal-cutters to drive an inbye air compressor, or to work the coal-cutters by electricity direct. And this electric power has been generated from the exhaust steam formerly disregarded and wasted.

Meanwhile condensers cannot be used with reciprocating winding engines on account of the difficulty in controlling them; and the compounding of existing reciprocating engines, and the installation of condensing plant gives such a narrow margin of profit with a disproportional increase of worry to the management, together with so heavy an initial expenditure, that it has been found preferable to run these engines non-condensing. But the advent of the exhaust and mixed pressure turbine has made it possible to utilize this hitherto tremendous waste of heat units by converting them into electric units.

Before describing, however, the application and the possibilities of this new power producer, it may be advantageous to first point out the chief differences between the reciprocating engine and the turbine, and to indicate when and how thew should be placed. In the case of the reciprocating engine, the heat units are, by their expansion in a cylinder and change of configuration, made available for useful work through the medium of a fly-wheel; while in a turbine this transformation of static heat energy into kinetic energy may be brought about in one of three different ways: (1) In the impulse turbine by the expansion of the steam in nozzles, impinging on buckets on the periphery of the turbine wheel, which in turn levers the shaft and attains as high a speed in some sizes as 30,000 revolutions per minute: (2) In the reaction turbine, by the alternate passage of the steam through revolving and fixed blades the expansion is performed on both sets of blades, the fixed blades acting as guides; and (3) the operation is performed by means of a combination of the first and the second.

Theoretical thermodynamics teach that when a given quantity of steam at a given pressure and temperature ex-

hausts into a condenser at a certain pressure and corresponding temperature, an equal number of units are available whether a reciprocating engine of a turbine has performed the functions.

The difference lies in the fact that the expansion of steam in a reciprocating engine is controlled by the size of the low pressure cylinder, and the maximum size to which this can be built economically, without undue cylinder condensation and friction, is generally acknowledged to be the equivalent of from 85 per cent. to 88 per cent. of the possible vacuum; while in the case of the turbine the expansion of the steam is only limited by the efficiency of the condensing plant. The higher the vacuum, the greater the efficiency of the turbine; so when purchasing a turbine set, it is absolutely essential to purchase the best condenser on the market.

A glance at the P.V. curve will at once show the greater work-producing capacity of the steam turbine than of the reciprocating engine. The curve shows the adiabatic expansion of unit weight of steam. This curve is theoretical, and only shows the wider limits the turbine can control; and it has nothing whatever to do with the mechanical efficiency of the power producers. The advantage the turbine has lies in its capacity of efficiency utilizing the vacuum.

The advantage of the utilization of this vacuum can be thoroughly appreciated when it is considered that one pound of saturated steam expanded from say 16 lbs. per sq. inch (a little above atmospheric) to 95 per cent. of possible vacuum, that is 0.7 lbs. per sq. inch, generates the same amount of heat units as does the same quantity of superheated steam at 572 F., expanded from 170 pounds per square inch absolute to about atmospheric pressure. Another way of demonstrating the thermo-dynamic advantages of the turbine is by the means of entropy diagram. The first diagram shows a non-condensing engine expanding from the average colliery pressure of 165 pounds per square inch absolute to 29 pounds absolute, and exhausting against a back pressure of 17 pounds absolute. This diagram represents the available energy performed by the non-condensing reciprocating engines at collieries and mines. The second diagram shows the reciprocating engine expanding the steam from 165 pounds absolute down to 10 pounds absolute, and exhausting into a 26-inch vacuum. The third diagram shows the non-condensing engine that performs the work in the first cast, now exhausting into an exhaust steam accumulator and a low pressure turbine utilizing this discarded steam and expanding it from 16 pounds absolute to 28 inches of vacuum.

The increase of available energy demonstrated in the last diagram, makes it so glaringly apparent that further reasoning is not necessary to demonstrate the advantages and economy of the exhaust steam turbine over the reciprocating engine when working with low pressure steam.

On looking at these diagrams the question arises why cannot the exhaust steam which one sees so frequently almost enveloping the whole of a bankhead of a deep mine, be used by a condenser. This problem has taxed the ingenuity of engineers for years, and the difficulties to be surmounted have caused such complications that any available advantages have been more than discounted by the initial expense and trouble in connection with the operation of the prime mover and its auxiliaries. When the extreme duties of a winding-engine winding out of a vertical shaft are realized, it is scarcely surprising that condensers are not in use.

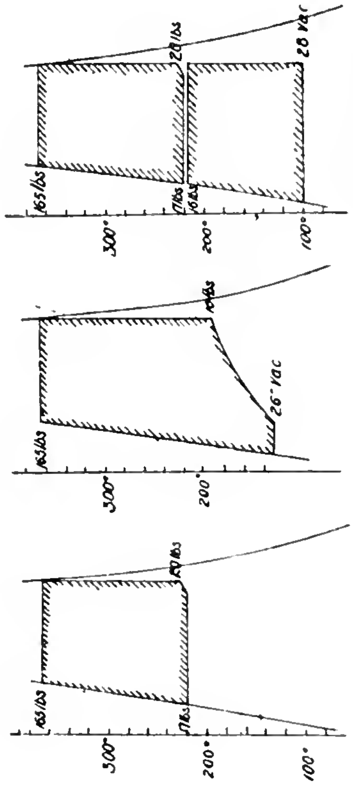
Some of the difficulties to overcome are: fluctuating loads; acute speed variations; reversals of direction of rotation, which have sometimes to take place quickly, and at almost any position of the engine; and, at the most, an average wind of from 20 to 30 seconds. These, then, are the difficulties to be surmounted, and which have baffled engineers for so long, and have resulted in the loss of countless millions of horse-power. The invention of the accumulator by Professor Rateau introduced the low pressure turbine into this field of intermittent steam, with very beneficial results.

Figure 3 is interesting, as it shows the amount of energy available by the adiabatic expansion of one pound of dry saturated steam when expanded from 120 pounds absolute; with the increase 0.5 in. of vacuum, from 27 in. to 29 in., with a barometer at 30 in. Expanded to atmospheric pressure we have 120,000 foot-pounds, and on the continuance of expansion to 1 lb. absolute, or 28 in. of vacuum the number of foot-pounds are almost doubled. In other words, the power available with a low pressure turbine, is increased almost 100 per cent. The utilization of this extra 100 per cent. by such a prime mover working on a 28-in. vacuum, is plotted in Fig. 4. This shows the consumption of steam per kw. hour at full load, with the amount of energy in kw. hours that can be recovered from a given quantity of exhaust steam per hour. On a 750 kw. set, the steam consumption is 36.5 lbs. per kw. hour or 39 lbs. per b.h.p., i.e., for every thousand pounds of exhaust steam per hour, 39 b.h.p. can be regained.

The history of the steam turbine is well known and hence any recapitulation is unnecessary, but it may be mentioned that it was not until the year 1902 that the exhaust steam turbine was introduced, when almost simultaneously engines of this type were patented by the Hon. C. A. Parsons and Prof. Rateau. The first Rateau turbine was installed at the Bonay mines in France.

In applying exhaust steam turbines to reciprocating engines at collieries and mines, there are two distinct propositions to be confronted. First, the case where the supply of exhaust steam is constant, but variable in quantity, and second, where the supply is intermittent and erratic, and where winding engines cease operating at night, but pumping must continue.

The first condition is brought about by fan engines feed pumps, and other auxiliary prime movers. Here a low pressure turbine is applicable, with the addition of a reducing valve, so as to reduce live steam in case of the exhaust steam failing in quantity and thus allowing the output of the turbine to drop below its working demands. This reducing of live steam in a valve before entering an exhaust steam turbine, is anything but economical and cannot be recommended. A turbine known as the mixed-pressure turbine has been devised to utilize this intermittent exhaust steam as well as utilizing live steam in an economical fashion when required to do so. This type of turbine is thus the most adaptable for colliery and mine work. Usually, when the exhaust steam is fairly constant, a receiver, consisting of an old Lancashire boiler-shell, suffices to steady the pressure for all practical purposes; but in extreme cases, and these are the conditions usually encountered at deep mines, it is necessary to resort to the thermal regenerative accumulator through which a comparatively steady supply of steam can be maintained even through the reciprocating engines may be stopped for an interval of five minutes. There are at the present day three or four types of regenerators on the market. Prof. Rateau has the honor of inventing two types of these accumulators, the functions of which are to store up surplus heat supplied when the reciprocating engines are running, and regenerating and delivering when the engines are at rest. These regenerative accumulators to be of a commercial possibility, must be so constructed that they shall have the capacity of storing enough heat units to supply the turbine with exhaust steam, should the exhaust steam be cut off for from, say, three to five minutes. In the scrap



Reciprocating Engine Non-Condensing

Reciprocating Engine, Condensing

Fig. 2.

Mixed Pressure Turbine utilizing Exhaust Steam

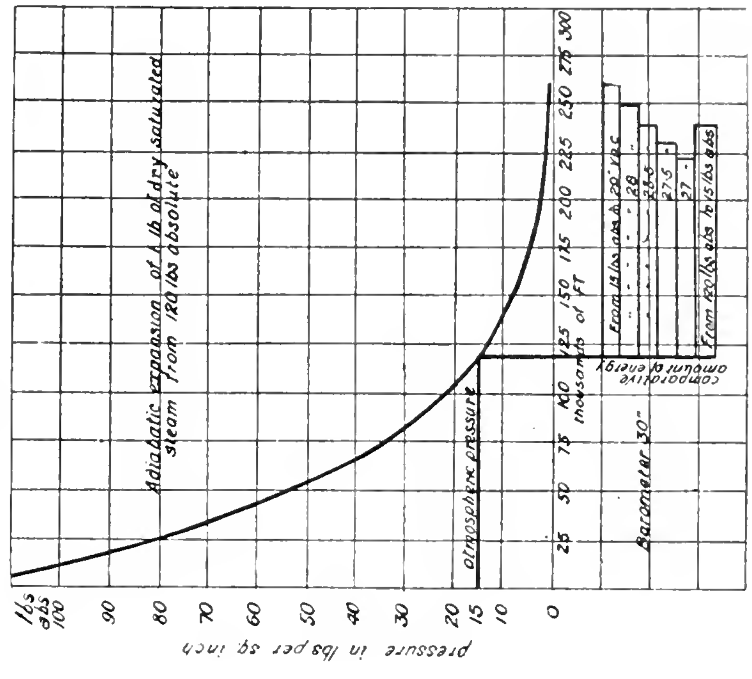
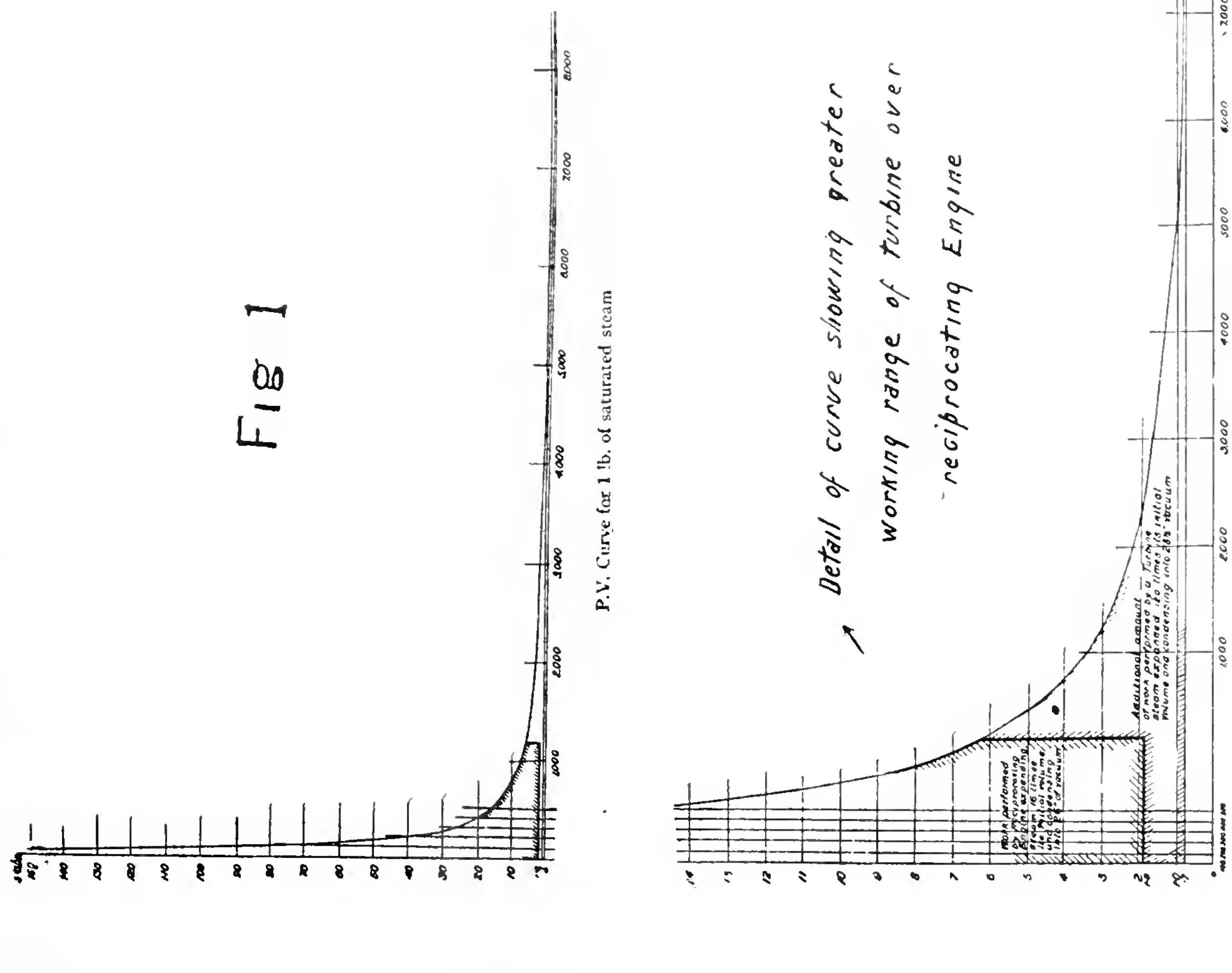


Fig. 3.



iron type of accumulator, the heat storing medium is scrap iron, which is packed in a loose fashion in an old Lancashire or Cornish boiler-shell. Very little water is required in this type. The exhaust steam condenses in the form of dew on the scrap iron and is re-evaporated when the pressure falls by the heat that is absorbed and retained by the iron. At the Hucknall Torkard Colliery, such an accumulator is in use. It consists of an old boiler-shell, 24 feet long by 6 feet in diameter, contains 50 tons of old rails and scrap iron, and supplies a 175 b.h.p. Rateau turbine during intermittances of 40 seconds. Very few of these accumulators are in use, and there is little likelihood of any further installations of this type on account of their initial cost and tremendous weight. In regenerators of this type, the ratio of the volume of water to iron is as eight to one.

The other type of accumulator invented by Prof. Rateau, is known as the water accumulator. The principle of the Rateau accumulator is to keep steam and water in constant and violent contact with one another in order to raise the temperature of the water to correspond with the pressure, else uncondensed steam would rise and escape through the auto-relief valve. Water in a secondary condition is a bad conductor for the rapid interchange of heat, and the method by which Rateau produced violent circulation in the condensing medium was by utilizing an old boiler-shell or a specially made accumulator shell of about 7 to 8 feet in diameter, the length depending on the capacity of the turbine, while inside the shell are placed longitudinal flues of oval section, with their major axis vertical. The tops of these flues are so placed that the water shall always be a foot above them, the water-level being maintained by a ball float valve. The vertical sides of the flues or tubes are perforated with holes, so that the exhaust steam when delivered into the flues, escapes through the perforations, sends the water into violent circulation, and rises to the surface. A baffle plate is so arranged that it will guide the water back to the bottom of the accumulator, at the same time preventing water from being carried into the turbine, which would be the equivalent of priming in a boiler plant. When the exhaust steam is in excess of the demand, the water is raised to boiling point and then any surplus steam escapes through an auto-relief valve; but when the demand is in excess of the supply the pressure falls inside the regenerator and the water then parts with the heat units it has absorbed by evaporating, thus supplying the turbine with a steady flow of steam and making up for the deficiency. By any chance, should the supply of steam fail, the pressure becomes still further reduced in the accumulator, and the steam in the exhaust pipes becomes liberated to the extent of the weight of the non-return valve, thus keeping the water in agitation, and by the excitation assists evaporation. The back pressure in a 7-ft. to 8-ft. diameter Rateau accumulator is small and is at a minimum when the water is steam saturated; but in the big sizes such at a 12-ft. size, there is a loss of about 3 per cent. for every pound of back pressure. To overcome this, a partition has been introduced dividing the water into two layers, and two sets of steam flues have been provided. The steam spaces about the water are in direct communication, hence the pressure in both compartments is equal.

In practice, the common limits of pressure in these regenerators varies usually from 15 to 18 lbs. per square inch absolute, the difference of temperature being 9.30 F.; that is 103.5 lbs. of water is required for every lb. of steam, since the latent heat of steam at these pressures is 961 B.t.u.'s. This figure in actual practice is raised to 250 lbs. as it is impossible to ensure that the whole of the water in the regenerator will be raised to the highest temperature. The steam is supplied to the turbine through a valve on the top of the regenerator, and here a baffle plate is placed to obstruct any water that may be carried in suspension with the out-going steam. On the inlet steam pipe a non-return valve is usually placed, in order that no water can return to the reciprocating engines when at rest.

In the case of deep mines possessing winding engines having cylinders of from 36 in. to 48 in. diameter and winding from vertical depths of from 2,000 feet to 4,000 feet, it is not only necessary, but economically essential to place some kind of receiver on the exhaust main between the regenerator and the reciprocating engines. This receiver need be only half the size of the accumulator. This assists greatly the regenerative organs of the accumulator, as it steadies the steam flow, acts as a storage cell and greatly assists when the pressure drops in the regenerator. It also has the tendency to prevent the occasional quarter of a pound of extra back pressure on the reciprocating engines when the first few strokes are performed. This receiver can also act as an oil separator, although it is advisable to fit an independent oil separator on the exhaust main. Not only does this oil separator prevent oil from passing through the condenser with the condense water frequently used for feed boiler purposes, but is reclaims a very large percentage of the lubricant oils, in itself an important consideration. A few staggered rows of vertical baffle plates with hollow sides and vertical curves are the essentials constituting this type of oil separator.

Another auxiliary in a turbine set is the condenser, and this will be elaborated on and the balance of article concluded in next week's issue.

CENTRIFUGAL FEED PUMPS FOR BOILERS.

An article on this subject, by Alfred Williams, appears in The Electrical World, in which he says:

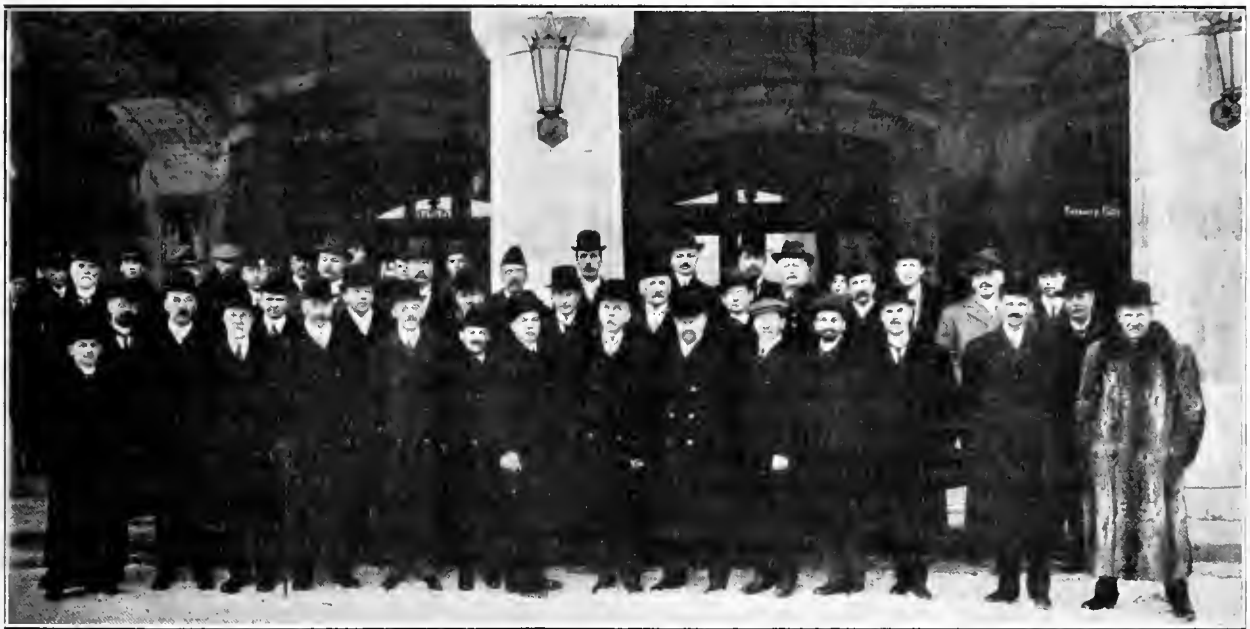
In most of the small central stations throughout the country the time-tried and time-honored simple reciprocating pump for boiler-feed purposes still holds sway, although in newer stations the compound steam-end reciprocating pump is used for the higher boiler pressures employed; but even the latter is fast giving way before the steam-turbine-driven or motor-driven centrifugal pump This change has not been forced owing to any superior economy on the part of the latter unit, but because of its easier operation and lower maintenance cost. There is considerable room for improvement in those stations equipped with the simple reciprocating pumps, especially where the latter call for some 200 to 300 lb. of steam per indicated horse-power. If steam must be used, it would be preferable to employ an independent steam engine which will operate at, say, 60 lb. of steam per indicated horse-power. An argument frequently brought out by persons who oppose the use of electric motors for driving boiler-feed pumps is that the motor does not offer sufficient variation in speed to meet ordinary conditions of practice without introducing resistance in the circuit. It is possible that very much energy might be wasted in this manner, and yet a great saving can be shown over the inefficient direct-acting steam pump. It has been suggested that in place of the single direct-acting steam pump a triplex pump be installed, and that this pump be driven by a constant-speed motor or belted from the main engines. The variations in the rate of pumping can be taken care of by placing a by-pass valve in the suction to the exhaust of one or two of the pump cylinders. Then to vary the rate of pumping it would only be necessary to open the by-pass valve more or less. With the by-pass valve shut the pump works at maximum output. By opening the two by-pass valves wide the rate of pumping in a triplex pump would be reduced two-thirds. Such a pump would be most economically driven from the main engine shaft.

The advantages and economy of using motor-driven or turbine-driven centrifugal pumps for feeding boilers are, however, too great to be ignored.

Among the points in favor of the centrifugal pump are the following: It has neither suction nor discharge valves; it possesses only one moving part which is in continuous rotary motion, and it delivers the water in a constant stream in contrast with the intermittent impulses of the ordinary duplex pump so widely employed for this class of service. Since the stream of water is constant and without impulses, there is no vibration in the pipes, and there is little chance for scale to deposit in them. The pump, moveover, possesses all the advantages of being valveless. There are, therefore, no plungers to be packed, no steam valves to reseat, and no pistons to require new rings from time to time. A feature of the pump which is paramount is that when running at constant speed it delivers water at a certain pressure, which it cannot exceed by more than a few per cent., even though the delivery pipe be completely closed. With the reciprocating pump the latter calamity usually means a broken pipe or pump. This feature of the centrifugal pump makes it possible for a fireman to shut off the feed to any of the boiler or to all of the boilers without shutting off the pump, which in many plants would entail leaving the boilers and going to another part of the station. It is thus possible to feed the boiler automatically by installing a ball-float for each boiler, which would control a balanced valve in the feed pipe. This makes it unnecessary to have connections with a line supplying steam to the pump, as the latter runs continuously whether any of the boilers are being fed or not. This method of automatic feeding makes the boilers independent of each other, and makes it unnecessary for the water line in all the boilers to be at the same level. This latter feature is important in stations containing several sizes of boilers or where some are of the vertical type and some of the horizontal type. It might be contended that the efficiency of a centrifugal pump operating under these circumstances would be very low when supplying only a small portion of its rated output, and that it would consume power when merely turning the water without delivering any. This objection in the case of a motor-driven centrifugal pump is of little moment when its many advantages are considered.—Electrical World.

TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS.

We have at different times referred in *The Canadian Engineer* to the International Geological Congress which is to be held in Toronto during the month of August this year. Through the courtesy of Mr. W. S. Lecky, secretary of the congress, we are pleased to present this week some further facts regarding this congress, also a photograph of the organization committee in connection with it, which held a session in Ottawa on the 4th of March.



Organization Committee, International Geological Congress, to be Held in Toronto August 6th to 14th, 1913.

At that meeting was considered the general arrangements in connection with the programme. On that occasion addresses were delivered by the president, Dr. Adams, on the general objects and work of the International Geological Congress; Dr. W. G. Miller delivered an address regarding the 10th session which was held in Mexico in 1906, and Dr. Coleman, of Toronto, spoke on the 11th session held in Sweden in 1910. Arrangements for the work of the 12th session to be held in Canada this year were described in detail by the General Secretary of the 12th congress, Mr. R. W. Brock.

It is expected that about one thousand delegates will attend the congress, six hundred professional geologists and about four hundred mining engineers, many of them coming from Europe and the United States.

The meetings of the congress will be held in Convocation Hall and lecture rooms of the University of Toronto. The congress will open Wednesday, August 6th, and will continue until Thursday, August 14th, excluding Sunday the 10th.

A series of very interesting excursions have been arranged, and as many of the men who will attend are university professors it is hoped that these excursions, together with the fact that our mines will be generally open to their inspection, the congress will have far-reaching effects.

HIGH-SPEED BEARINGS.

The issue of *The Canadian Engineer* of March 20th, contained a few cuts and an abstract of a paper on "High-Speed Bearings" by J. C. Balfry, read before the Rugby Engineering Society, England. The former article contained a description of the different types of bearings. This week we publish as abstract of the report which deals more particularly with the results and conclusions on the subject.

The total friction work in a particular bearing can be reduced by shortening it. But here one enters dangerous ground, for the manufacturer has to consider much more than frictional losses and the safe running of the machine at normal speeds. He has to think of the stilling of such vibrations as are set up in the shaft when the latter is passing through a critical speed, as well as a possible reduction in oil supply (this depending upon the lubrication arrangements) when the speed of the shaft is declining.

Pressures.—The ordinary pressures to-day are from 50 to 90 lb. per sq. in. of projected bearing surface. In the discussion on a paper read before the American Society of Mechanical Engineers by Professor Christie, it is reported that Professor Hodgkinson remarked that 80 ft. per sec. and 100 lb. per sq. in. were commonly employed, and he saw no reason why these velocities and pressures could not be materially exceeded. This, to some extent, agrees with Lasche's experiments, for within fairly large limits $p \times \mu$ is practically constant.

Velocities.—As already stated, present-day practice with bearings of this kind rules that velocities should not exceed 60 ft. per sec. As μ increases but slightly between 30 ft. per sec. and 80 ft. per sec., there is little fear that a moderate increase on the higher figure will have any ill effect on the bearing, provided that the temperature is not allowed to rise too high and vibration is not forgotten. Allford's work on "Bearings and Their Lubrication" contains a curve showing the relation between pressure and velocity, used by the General Electric Company, of America, for perfect film lubrication. The following are readings taken from the curve:—

V. in Ft./Sec.	p = Lb. per Sq. In.
20	167
30	190
40	208
60	229
73.5	235

From the above it will be noticed that with increase of velocity there is likewise an allowable increase of pressure. Lasche shows that within the limits of his experiments, with v and t constant, the increase of pressure was accomplished by a decrease in μ. Therefore, since $p \times \mu \times v =$ friction work per sq. in. of projected surface, the friction work is affected only by variation in velocity. These deductions are to a certain extent borne out by data taken from the G.E.C. curve.

Many turbine builders assume that for running speeds μ is a constant quantity, and is left out of account in determining the size of a bearing. The determining factors are then the product of pressure and velocity,

$$p \times v \text{ varies from } 2{,}500 \text{ to } 5{,}500;$$

but in the latter product water cooling is resorted to by some builders.

Oiling.—With pressure or pressure-head systems, oil is admitted to a bearing usually either at the sides or at the top. Each system has its advocates, and it is well to remember Beauchamp Tower's classical experiment before attempting to admit oil at other places. Tower showed that the maximum pressure per unit area in the oil film was about twice as great as the calculated mean pressure per unit area on the projected surface of the bearing. Osborne Reynolds has shown, and others have confirmed, that the position of the shaft within the bearing varies with increase of load, and that the point of maximum pressure, which is on the "off" or leaving side, and not on the "on" side, as is sometimes supposed, moves up the "off" side of the bottom half of the bearing and back again to the bottom as the load is increased. For example, imagine that a shaft is rotating in a counterclockwise direction within a bearing, the end view of which is presented towards the reader. The shaft, whose weight compels it to run on the bottom half of the bearing, rotates at first in the lowest position. Using the four cardinal points to simplify matters, the shaft rubs first at S., with increase of load it gradually mounts up to E., dropping to S.E. as the load is still further increased. It is useless, then, to attempt to pump oil between journal and bearing surface anywhere between S. and E. We therefore admit oil at N., W., or S.W., these being the most convenient places.

Professor Goodman has shown that a reduction of the arc of "contact" of the bearing surface on the journal greatly reduces frictional losses in the bearings.

An inspection of Figs. 5 and 7 shows that this fact has been taken advantage of by the reduction of the effective bearing surface on the bottom half by the well-bevelled oil channels at the horizontal centre lines.

The quantity of oil to be delivered to a bearing surface is proportional to its projected area. The following table gives the practice of three leading turbine builders:—

Gallons per Sq. In. per Minute.	Oil Pressure in Lb. per Sq. In.
0.05	45 to 60
0.05	5 to 10
0.01	—

If $p =$ say 60 lb per sq. in. on the projected area;
$\mu =$ coefficient of friction $= 0.025$;
$v =$ velocity in ft. per sec., say 60 ft.;
$p \times \mu \times v =$ work done in ft.-lb. per sq. in. per sec.
$60 \times 0.025 \times 60 \times 60 = 5{,}400$ ft.-lb. per min.

Taking specific heat of oil at 0.4, and sp. gr. as 0.88,
$Q =$ gals. delivered per sq. in. per min. $= 0.45$.
$T_1 =$ temperature of inlet oil, Fahrenheit.
$T_2 =$ temperature of outlet oil, Fahrenheit.
$10 \times 0.88 \times 0.4\,(T_2 - T_1)\,Q =$ B.Th.U. taken up by oil in passing through bearing per pound of oil delivered.

With $T_2 = 130°$ F. and $T_1 = 100°$ F., B.Th.U. per min. capable of being taken up by the oil is $47.5 = 37{,}000$ ft.-lb. per min.

As the journal generates only 5,400 ft.-lb. of friction work per minute per sq. in., we see that there is more than sufficient oil to keep the temperature of the bushes low.

The effect of shaft vibration has to be remembered, and it is more than probable that if this happens to be excessive much more heat is generated through vibration than by friction due to p, μ, and v only.

The selection of a suitable oil is of importance. Great viscosity means loss of power, μ being greater than with small viscosity. Provided that complete lubrication is obtained, the thinnest oil that will do the work will prove the most economical. The following results were obtained on a Sternol patent oil-testing machine at a pressure of 100 lb. per sq. in. at 100 revolutions per min. Duration of test was 55 mins.:—

Oil No.	Relative Friction at Beginning.	Relative Friction at End.	Temp. at Beginning. Deg. F.	Temp. at End. Deg. F.
4	1.45	0.9	68	107
5	2.8	1.25	68	126
6	3.75	1.5	68	132

The curves from which the above were taken fall very gradually.

The effect on the relative coefficient of friction is shown with the temperature rise, the most suitable oil of the three being No. 4, which has the lowest coefficient of friction and lowest temperature rise.

In the following table results of tests on three turbine oils are given; they were obtained with the same machine as were the previous ones at 100 revolutions per min.:—

Oil No.	Relative Friction at Beginning.	Relative Friction at End.	Temp. at Beginning. Deg. F.	Temp. at End. Deg. F.
1	1.8	0.3	86	147
2	5	1.15	86	147
3	6.5	1.25	86	147

No. 1 gives the lowest coefficient of friction at all temperatures from 86° to 147° F. It will be noticed that the oil is colorless, and is therefore as free from impurities as it is possible to get it. The comparative thickness of these last three lubricants at various temperatures is indicated in the third column. According to tests made on the Sternol oil-testing machine, the quantity of oil required varies according to the quality of the lubricant. It is not correct to say that by using a cheaper oil one may use more of it, for if the oil is put on in very large quantities μ is not reduced whatever.

No. 1 oil—Thin, colorless.
No. 2 oil—Green-golden, somewhat heavy.
No. 3 oil—Heavy, golden.
No. 4 oil—Thin, golden.
No. 5 oil—Deep golden, medium.
No. 6 oil—Golden, medium.

In ordinary turbine practice oil is delivered to the bearings at from 100° to 120° F., and returned at from 130° to 150° F.

Radiation.—Lasche has shown that the quantity of heat radiated from a bearing depends upon the extent of the surface exposed to the lower temperature of the surrounding air. Thus a bearing having good metallic contact with a large housing will be able to get rid of a great deal more friction heat than will one that is itself in contact with the cooler surrounding atmosphere.

In Fig. 13 is shown a curve indicating the amount of heat, expressed in foot-pounds, that may be expected to be dissipated into the surrounding air per sec. per sq. in. of projected area.

If Wr = work which bearing can dissipate in foot-pounds per sec. per sq. in. of projected area, t = temperature difference in Fahrenheit degrees, can be closely represented by the equation:

$$Wr = \frac{(t + 31)^2}{3,200}.$$

This may be used when the bearing in question has a relatively thin housing, and is located in still air. If the bearing is situated in a draught—e.g., close to rotating armatures—the right-hand side of the equation may be multiplied by two.

The following table gives the composition of some of the best known anti-friction alloys:—

	Copper.	Lead.	Antimony.	Tin.	Iron.
White metal ...	.....	87.92	12.08	.....	.....
Delta metal ...	92.39	5.1	.....	2.37	0.07
Magnolia metal	.....	83.55	16.45	.....	.....
Babbitt metal .	8.3	.....	8.3	.....	.....

By the use of the "Eatonia" process in the casting of ordinary white-metal linings for bearings, the bearing surface is rendered much more dense, the molecular contraction is much finer, and there is an absence of segregation. Experiments to show the comparison between a bearing lined with white metal, and another of the same size also lined with white metal but "Eatoniaized," indicated that under exactly similar conditions the former seized up when the temperature of the oil-bath rose to 137° F., and the latter showed no signs of seizing up even at 149° F. The pressures were 1,000 lb. per sq in. in each case, oil-bath lubrication was used, and the journal speed was nearly 8 ft. per sec.

Ball Bearings.—A paper bearing our title would hardly be complete without some mention being made of the place that ball bearings are beginning to take in the development of high-speed electrical machinery.

The ball bearing in its various forms has been used with electric generators and motors for some time, not only with light but with heavy machines. Up to the present this form of bearing has not found favor with turbine builders, nor, generally speaking, with generator makers.

It is no doubt due to fear of ball breakage through vibration at the critical speeds of the shafts, and the knowledge of the disastrous consequences which such failure would produce, that turbine makers have not advanced in their adoption of ball bearings. Since ordinary turbine shafts revolve at speeds between 4,000 revolutions per min. and 750 revolutions per min., and weigh from one ton upwards, the weights to be carried at these speeds are consequently high.

It is probable that the first cost, bearing for bearing, is greater in the case of the ball type than with the friction type, but the lubrication arrangements of the former are insignificant when compared with those of the latter. The oil consumption is very small indeed with balls, and the coefficient of friction at starting is about the same as running, this being approximately 0.002 to 0.003. It is recommended that for high-speed ball bearings a somewhat thinner oil be used, and a little more of it than would be necessary with slow-running ball bearings. The oil used should be of a non-corrosive nature and free from impurities, especially those likely to act with the oil and produce results in the same way as fine emery powder or even chalk would be expected to do.

After a bearing suitable to the load, speed, and general conditions has been selected, the three most important points to bear in mind are: (1) Accurate fitting; (2) correct alignment; (3) protection from dirt and moisture.

With most makers the load (corresponding to the speed) on a ball journal bearing suitable for a horizontal shaft may be said to vary inversely as the cube root of the speed, or, expressed in algebraic form:—

$$\text{Safe load} \propto \frac{1}{\sqrt[3]{\text{Revs. per min.}}}$$

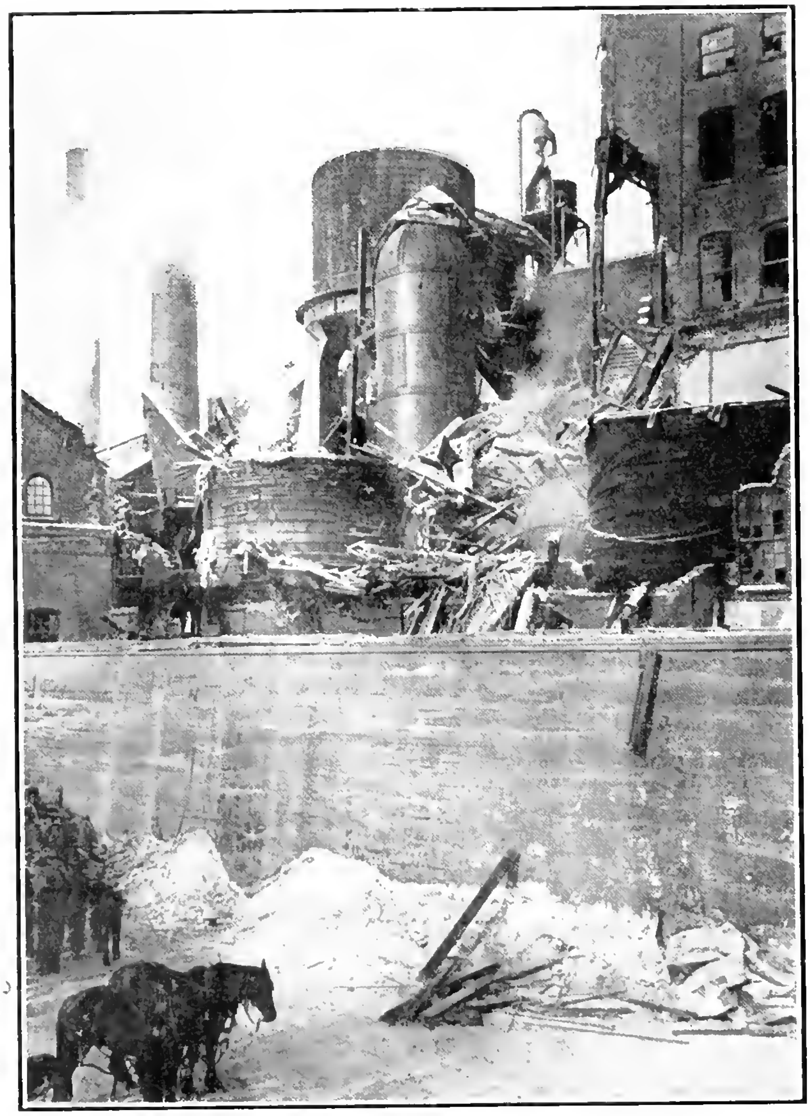
For thrust bearings—

$$\text{Safe load} \propto \frac{1}{\sqrt{\text{Revs. per min.}}}$$

Canadian railroads plan the construction of 2,700 miles of road in 1913, costing $41,000,000, compared with 1,075 in 1912, costing $30,000,000.

SULPHITE DIGESTER EXPLOSION.

The illustration which accompanies this article will give some idea of the tremendous damage done recently at Grand Mere, Quebec, by the explosion of the sulphide digester of the Laurentide Paper Company. A digester is the vessel in which wood is treated with acid in paper manufacture, and is operated at a pressure of 85 to 90 lbs. per square inch. It was 45 feet high by 14 feet diameter. It was built in three courses of three sheets of steel for each course. These steel plates were one inch thick, united by butt joints with single strops of the same material one and one-sixteenth inches thick. The vertical seams were triple rivetted, the girth seams double rivetted. It was lined first with lead about three inches thick, and then with a cement and tile lining about eight inches thick, the object of this lining being to prevent the acid used in cooking the pulpwood coming into contact with the steel sheets of the digester.



Wreckage from Sulphite Digester Explosion.

The vessel had been regularly inspected by inspectors of the Boiler Inspection and Insurance Company, and it is satisfactory to know that the explosion was due to a cause entirely beyond the control of both the owners and the inspecting company.

The initial rupture occurred in the strap on one of the vertical seams in the middle course, which was eight feet six inches in width. The rupture spread along both of the girth straps of this course, which opened up and was torn from the upper and lower portions of the digester. The top portion was blown directly upwards, falling back on the foundation of the digester house, while the lower portion was blown through the south wall of the digester house, falling on and destroying the blow tanks used to receive the cook when emptying the digesters. The middle course was lying on top of the lower portion and was straightened out with the force of the explosion almost flat. There were no tears or ruptures in any of the plates, but that the failure in material was confined solely to the straps, a fact which can be taken to corroborate the opinion subsequently reached as to the cause of the explosion.

The wrecked digester was very carefully and thoroughly examined soon after the explosion, and the conclusion reached was that the explosion was due to a hidden crack in the strap which first failed, and which, starting from the inner surface, gradually worked its way towards the exterior. Its position between the strap and the sheet made it difficult to discover the defect. What supports the conclusion is the fact that of the vertical straps in the same course one showed a crack on its inner surface about two-thirds of its entire length and in a position which a crack of this nature would be expected to occupy. A similar crack was found in one of the vertical straps that had been removed from one of the other digesters.

The expediency of removing the entire lining of a digester at regular intervals and making a thorough internal examination of the shell, is, in spite of the cost of such a step, deserving of serious consideration. It is certain that the cost would be insignificant as compared with the loss that might be avoided. From such an examination only can the strength of the vessel and the pressure at which it is safe to operate it be accurately determined from time to time. In some continental countries such a step at fixed intervals is compulsory by law.

PANAMA CANAL WORK IN JANUARY.

The grand total of canal excavation to February 1 was 190,892,279 cubic yards, leaving to be excavated 27,246,020 cubic yards. Since the last monthly report of excavation was published there have been added to the excavation yet to be accomplished in Culebra Cut 5,634,161 cubic yards on account of the slides that have been developing there. The total excavation for the month of January was 2,612,020 cubic yards. The dry excavation amounted to 1,672,117 cubic yards and was entirely by steamshovels. The dredges and monitors removed 939,903 cubic yards.

In the Atlantic Division, the total excavation was 555,111 cubic yards. Of this total 46,773 cubic yards consisted of dry excavation at Gatun Locks, and the remainder was wet excavation—508,338 cubic yards from the Atlantic entrance.

The total excavation in the Central Division was 1,135,580 cubic yards, which includes 18,360 cubic yards in the Culebra Cut section charged to Obispo Diversion.

In the Pacific Division, the total excavation was 912,329 cubic yards, 489,764 cubic yards of which consisted of dry excavation. Of the 431,565 cubic yards of wet excavation 215,025 cubic yards were from the channel, and 216,540 cubic yards were taken out at the Balboa terminals.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

Elements of Heat-Power Engineering. By C. F. Hirshfeld, M.M.E., and Wm. N. Barnard, M.E. 8 vo., xiii. + 811 pages; 480 figures. Price, $5.00 net. John Wiley and Sons, New York.

Reviewed by A. S. L. Barnes, A,M.I.E.E.*

The authors of this book are professors, respectively, of Power and Steam Engineering at Sibley College, Cornell University, Ithaca, N.Y. As set forth in the preface, an attempt has been made "to include in a single volume not only the elementary thermodynamic theory of gases and vapors and of their cycles, but also the consideration of the sources of heat, the methods of making it available for useful purposes, its utilization in the various types of heat-driven prime movers and their auxiliary apparatus, together with a discussion of the fundamental theory, the ideal and actual performance, and the practical considerations connected with such apparatus."

The book is said to be intended primarily for engineering students, but there is much in it which will be found useful by those who have gone beyond their college days.

The arrangement of this work is very good, being subdivided in such a manner as to make reference to any part a very easy matter; approximately the first half is theory, while the latter half is devoted to descriptions and discussion of various types of steam engines, steam turbines, boilers, gas engines, gas plants, etc.

Although, for many persons, the mathematics in the book will prove somewhat too much, as a knowledge of calculus is presumed, a great deal of useful information may be gleaned from its pages, even by those who cannot follow the equations.

From cover to cover it is evident that the authors have spared no effort to render their work of the greatest value to those for whom it is intended, and the book is worthy of being classed as a standard text book on the subject.

The earlier chapters, commencing with the elementary laws of thermodynamics and of gases, go on to discuss expansions and compressions of the latter, such as take place in all engines using heat as a source of power, curves of entropy changes, various gas cycles, such as the Carnot, Stirling and Ericsson cycles are taken up at considerable length and the advantage of theorizing about ideal conditions is clearly shown in that it enables one to understand what would be the maximum efficiency obtainable under such conditions and in what direction success may be sought.

Later on the properties of steam are dealt with as being the gas in most general use for power purposes; it is comforting here to learn that of the following two formulae the latter is accurate enough for ordinary engineering purposes:

(λ = total heat of steam).

(1) $\lambda = 1150.3 + 0.3745\ (tv - 212) - 0.00055\ (tv - 212)^2$.

(2) $\lambda = 1091.7 + 0.305\ (tv - 32)$.

The latter, it will be noted, is the old Regnault formula with which all steam engineers with any knowledge of theory must be familiar; the first formula is apparently a new one of slightly greater accuracy, developed by Dr. H. N. Davis three or four years ago. The latent heat of vaporization is given in this book as 970 B.th.u. The old value, it will be remembered, was 966.6.

Your practical engineer says that an ounce of practice is worth a pound of theory, but the futility of trying to get along entirely without theory may be well illustrated in the case of a steam engine where it can be proved beforehand that the maximum theoretical efficiency is only some 30 or 40 per cent.; of course, in actual engines it is less still, seldom higher than 25 and sometimes as low as 5 per cent. Theory, in this case, enables one to know what degree of excellence is possible and in what directions lie the greatest hope of success. Without such knowledge in designing "heat-power" plants needless mistakes and disappointments would be inevitable.

In Chapter XV. a good deal of space is allotted to the "Action of Steam in Real Engines," and in Chapter XVI. various methods of decreasing cylinder condensation are discussed. It is herein that one of the fundamental reasons why large engines should be more economical than small ones is pointed out, viz., that in large cylinders the volume enclosed is greater in relation to the radiating surface of the cylinder than in small ones and therefore the cylinder condensation in the former will be relatively less.

Following the above are chapters on various types of steam engines, governors, valve gears, indicator diagrams, etc.

Steam turbines are next dealt with, the ideal turbine coming first, followed by descriptions and drawings of De Laval, Rateau, Zoelly, Curtis, Parsons and other types.

External and internal combustion gas engines succeed the turbines, the former being typified by the various kinds of hot air engines which have from time to time been developed. The chief characteristic of such engines appears to be their extremely low thermal efficiency.

* Hydro-Electric Power Commission.

Internal combustion engines are, of course, very much more satisfactory, and a good deal of space is devoted to them.

The chapters dealing with "Fuels," "Combustion" and "Actual Combustion of Fuels" are very good, and in entire accord with the latest ideas and practice.

Boilers, Superheaters, Draft and Draft Apparatus, Gas Producers and Producer Gas, Feed Water Heaters, Condensers, Water Purification, Power Plants, Air Compressors and Refrigerating Machinery form the subjects of the concluding chapters, after which come problems suitable for students, an appendix containing tables of the properties of saturated and superheated steam, together with a temperature-entropy diagram and a heat-entropy chart.

A copious index brings to a close a book ambitious in its scope, but well carried out, and one which would be very useful to engineers of large electric generating stations and similar plants.

A Textbook of Theodolite Surveying and Levelling.—By James Park, Professor of Mining Engineering in the University of Otago, Dunedin, New Zealand. Published by Charles Griffin & Co., Limited, London. Second edition; 5½ x 8 ins.; 320 pages; 130 illustrations. Price $1.85.

Reviewed by J. B. Harvey, M.Sc.*

This book is intended to be an elementary textbook to cover a two years' course in surveyng. As the title indicates, surveying with the theodolite is dealt with almost exclusively, the author's contention being that at the present time practically all surveying is done with this instrument.

The author's experience seems to have been in the southern hemisphere and more particularly in New Zealand, and, judging from such statements as the following: "The graduated horizontal circle on most theodolites is a frustum of a cone," one must conclude that he is not familiar with the usual style of transit used in Canada.

Chapter I. deals with the care and adjustment of the instrument. Chapter II. is a short one on chains and steel bands. Chapter III. is on obstacles to alignment. Chapters IV. and V. deal with the measurement of angles, traversing and bearings generally. Chapters VI., VII. and VIII. deal with calculations, such as latitudes and departures, omitted lines, areas, etc. Chapter IX. is on the subdivision of land. Chapter X. is on triangulation. Chapter XI. is a long one, covering nearly 100 pages, and deals with astronomical observations. Here, as in other parts of the book, the author makes use of various formulæ, the derivation of which are not given, nor is there any indication as to where one might look for solutions. Chapter XII. deals with levelling, contouring and the bathymetrical survey of lakes. Chapter XIII. is on railway curves. This is after the usual English practice, where the curve is figured from a stated radius and not from some degree of curve, as is our usual practice. Chapter XIV. is a short one on mine surveying.

Except for the fact that some of the terminology does not agree with Canadian practice, and that practically all the numerical examples, especially those in the chapter on astronomy, are from New Zealand, and are thus not always suited to our latitude, the book should make an excellent elementary text. The explanations are usually short and to the point. The text is well supplied with actual problems completely worked out, and also with numerous diagrams and illustrations.

The book might be criticized for having too much space devoted to astronomy.

* Assistant Professor of Surveying and Geodesy, McGill University.

The Effects of Errors in Surveying.—By Henry Briggs, M.Sc., head of the Mining Department in the Heriot Watt College, Edinburgh. Published by Charles Griffin & Co., London. Cloth; size, 5½ x 8 ins.; 179 pages, 22 cuts. Price, $1.25 net.

Reviewed by J. B. Harvey, M.Sc.

"No branch of mathematics is treated in this country (Great Britain) less according to its deserts than that known as the Theory of Probabilities, of which the Theory of Errors is a part." This statement of the author applies about equally well to Canada, and accordingly this book can be recommended to any surveyor or engineer who would like to get some idea of the effect of accidental errors on his surveys.

The author, recognizing the fact that there are many excellent textbooks on the purely mathematical side of the Theory of Errors, devotes the major portion of his book to practical applications of the theory that should be of use to the working surveyor.

Instead of using the Probable Error, or Mean Square Error, as is done in nearly all works on this subject, the author makes use of the Average Error, which he defines as "the arithmetic mean of the separate errors, taken all with the same sign, either plus or minus."

The headings of the various chapters give a fairly clear idea of the matter contained in each: The Analysis of Error, The Propagation of Error in Traversing, The Best Shape of Triangles, The Application of the Methods of Determining Average Error to Certain Problems in Traversing, and The Propagation of Error in Minor Triangulation. The last chapter is a summary of the results obtained in the foregoing chapters, thus providing easy access to the conclusions reached. The book is also well indexed, and contains a number of special tables which would facilitate calculations of this kind.

Only an ordinary knowledge of mathematics is required to read this book. The explanations are well written, and, followed as they usually are by numerical examples, there should be no difficulty in applying the author's conclusions to one's own problems. A great many of the applications given are taken from mining surveys.

The book is not intended for use in high-class Geodetic surveying.

Applied Statics. By Louis A. Martin, Jr., Professor of Mechanics in Stevens Institute. 198 pages. Price, $1.50 net. John Wiley and Sons.

Reviewed by P. Gillespie, B.A.Sc.*

This is the fourth of Professor Martin's series of text books on mechanics, the preceding companion volumes being "Statics," "Kinematics and Kinetics" and "Mechanics of Materials." Typographically and otherwise the make-up of this volume is similar to that of its predecessors. It measures 7½ x 5 inches, and the paper and type are of the usual excellent quality. Many of the illustrations are of structures and machines. These, wisely, are chiefly diagrammatics, showing the mechanical essentials only, and in consequence are not complicated by unnecessary lines. Emphasis through the medium of black letter type is a feature of the text.

The book is intended by the author as an introduction to structural and machine design. It endeavors to encourage the student "to think and not to memorize," and is methodical and progressive in its treatment. Sufficient of the calculus is employed to give to the text a zest for the student who has read the elements of this branch of pure science. In consequence, the book is scarcely in the class usually designated as elementary.

* Associate Professor of Applied Mechanics, University of Toronto.

Not the least commendable feature is the excellent series of problems, numbering upwards of three hundred in all. These continue throughout all chapters and are of such a character that the student is led to realize that the subject he is studying has something beyond a mere academic interest. The book should commend itself to teachers and students.

The New Steam Tables, together with their Derivation and Application.—By C. A. M. Smith, M.Sc., and A. G. Warren, B.Sc., with an Introduction by Sir J. A. Ewing, K.C.B., F.R.S.. Publishers, Constable & Company, Limited, London. Cloth; size, 5½ x 8½ in.; pp. xii. + 101, with Mollier Chart inserted in cover. Price, $1.00 net.

Reviewed by A. R. Roberts.*

The great amount of research work in the last few years on the properties of steam has resulted in modifications of the values determined by Regnault, and made necessary new tables for the convenience of engineers and students.

Several sets of tables, in addition to the one under review, are available at the present time. They are all based on the same experimental work and give practically the same values, but differ in their arrangement and in the method of calculation adopted.

The New Steam Tables are calculated from a series of formulæ deduced by the aid of well-known thermodynamic principles from an empirical characteristic equation connecting the pressure, volume, and temperature of steam. These formulæ are due to H. L. Callendar, F.R.S. The constants in the various formulæ have been adjusted to accord with the latest experimental data. The values of the properties, calculated in this manner, are likely to be more consistent among themselves, though not necessarily in better agreement with the experimental data, than those calculated more directly from empirical formulæ.

A comparison of the values in these tables with those in Marks and Davis' shows considerable differences in many places, particularly in the Latent and Total Heats at high pressures. These differences, however, are of little importance in ordinary engineering work.

The New Steam Tables are arranged in two sets. The first set uses the "Pound-Centigrade" system, which is beginning to find favor with English-speaking engineers; and the second, the "Pound-Fahrenheit" system. In each set are two tables of the usual properties of Saturated Steam, one on a pressure base and the other on a temperature base, and two tables of the Specific Heat of Superheated Steam, one giving instantaneous and the other mean values.

The reviewer is of the opinion that a more complete tabulation of the properties of Superheated Steam would greatly increase the usefulness of the book.

Purification of Water.—By T. Aird Murray, M. Can. Soc. C.E.

A pamphlet containing 36 pages, in which the author presents a number of general principles involved where the purification of water is under consideration. The pamphlet, which is based on a paper read before the annual meeting of the Canadian Public Health Association, Toronto, 1912, describes slow and rapid sand filtration methods, and a very interesting series of tables covering the installation cost of slow sand and mechanical filters in various cities in the United States; also tables showing the operating costs of slow sand and mechanical filter plants.

The pamphlet contains a number of illustrations, together with an extract which appeared in *The Canadian Engineer* of November 9th, 1911, describing the mechanical filtration plant at Saskatoon, Sask. To those who are at all interested in this subject this pamphlet will prove very useful. The author will be glad to supply copies to anyone interested on payment of postage.

*Associate Professor of Mechanical Engineering, McGill University.

Directory of Cement, Gypsum and Lime Manufacturers.—Seventh edition. Leather cover; 2½ x 4 inches; 274 pages. Price, $1.00. Cement Era, 1207 Morton Building, Chicago, Ill.

The purpose of the Directory is, first, to present a complete list of manufacturers, so that any prospective purchaser of these products might locate at a glance any near-by mill. The publishers present in condensed forms lists which are very useful and necessary to the proper conduct of business relating to the manufacturers. It contains a list and location of mills in the United States, Canada and Mexico; alphabetical list of officers, superintendents and chemists of cement companies; list of brands of cement companies; list of gypsum companies; list of lime companies; buyers' guide, statistics on output of Portland cement, gypsum and lime.

Notice.—In the review of Martin's "Design and Construction of Steam Turbines," published on page 380 in the issue of *The Canadian Engineer* of February 27th, 1913, we omitted to state that Messrs. Renouf Publishing Company, Montreal, were the Canadian agents for this book. We would like to take this opportunity of notifying our readers of same.

PUBLICATIONS RECEIVED.

Application for Revision of Toronto Building By-law.—55 pages. Apply to City Architect, Toronto, Ont.

Works Administration.—28 pages.—By Gunn, Richards & Company. H. Victor Brayley, C.E., Canadian manager, Ottawa.

Port of Montreal.—177 pages.—Commercial Review, season of 1912. Published by Gazette Printing Company, Montreal.

Mineral Production of Canada.—Preliminary report for calendar year, 1912. By J. McLeish, B.A., Department of Mines, Ottawa.

Five Thousand Facts About Canada.—By Frank Yeigh. 68 pages. Price, 25 cents. Published by Canadian Facts Publishing Company, 588 Huron Street, Toronto.

Fredericton, N.B.—9 x 6 in.; 60 pages. A well-illustrated description of Fredericton and its advantages. Issued by the Publicity Commissioner, Board of Trade, Fredericton, N.B.

Western Canada Irrigation Association.—Report of the sixth annual Convention, held at Kelowna, B.C. 200 pages: 10 x 7 in. Published by the Department of the Interior, Ottawa.

Railway Routes in Alaska.—Transmitting reports of Alaska Railroad Commission. 170 pages, with maps, etc. Document No. 1346. House of Representatives, Washington, D.C.

Columbia River Power Project, near Dallas, Oregon.—By J. H. Lewis, State Engineer, with Technical Report by L. F. Harza and V. H. Reineking; 56 pages. Bulletin No. 3, Office of State Engineer, Salem, Oregon.

Forest Products of Canada.—Bulletin No. 34, on Lumber, Square Timber, Lath and Shingles; 36 pages. Bulletin No. 35, on Poles and Cross-ties; 18 pages. Both by R. G. Lewis, B.Sc.F. Issued by the Department of the Interior, Ottawa.

Pyrites in Canada.—Its occurrence, exploitation, dressing and uses. By A. W. G. Wilson, Chief of the Metal Mines Division, Ottawa. 200 pages, with maps and illus-

trations. Published by the Department of Mines, Ottawa, Ont.

Data for Use in Designing Culverts and Short-span Bridges.—By Charles H. Moorefield, Highway Engineer, Office of Public Roads; 40 pages. Bulletin No. 45, Office of Public Roads. Issued by the United States Department of Agriculture, Washington, D.C.

Congres Geologique International.—Being second circular issued as regards the International Geological Congress to be held in Canada, 1913. Gives programme and details of arrangements to entertain visitors. Issued by the Secretary, Twelfth International Geological Congress, Victoria Memorial Museum, Ottawa.

CATALOGUES RECEIVED.

Engineering Books.—For 1912. 128 pages. Published by McGraw Hill Book Co., 239 West 39th Street, New York.

The Industrial Building.—Norman A. Hill, supervising engineer and manager. Catalogue of 20 pages of details. Apply 212 Kent Building, Toronto.

Reversible Road Cars for Heavy Freight.—By Buffalo Pitts Company. A handsomely illustrated catalogue 12 x 9 in.; 40 pages. Write Buffalo Pitts Company, Buffalo, N.Y.

Every Man's Encyclopædia.—Twelve volumes of about 640 pages each. Cloth; 7 x 4½ in. Price per volume, cloth, 30 cents; linen-faced cloth, 45 cents; quarter pigskin, 60 cents. J. M. Dent & Sons, Limited, Toronto.

Bridges.—By Ontario Bridge Company. 27 pages; handsomely illustrated with photos, and containing certified letters of work done by different engineers and corporations concerned. Address, main office, Manning Chambers, 72 Queen Street West, Toronto.

Announcement of the Organization of the J. C. White Engineering Corporation and the J. C. White Management Corporation, to assume the functions of J. G. White & Co., Inc. 25 pages of beautifully illustrated and published information. Address, New York.

Chicago Pneumatic Tool Company.—Three catalogues of eight pages each, one being Bulletin No. 129 on Hose, Hose Couplings and Hose Clamp Tools; Bulletin No. 126 on Compression Riveters; Bulletin No. 130, Lubrication of Pneumatic Tools. Canadian offices, the Holden Company, Limited, Montreal, Toronto and Winnipeg.

The Luitwieler System of Water Supply.—Describes the Luitweiler non-pulsating deep well and triplex pumps, hydro-pneumatic system of water supply, elevated tank system, special double service pumps for combination hard and soft water supply, automatic pressure controllers, etc., in an interesting and attractively arranged bulletin. Price lists and full details regarding shipping weight, tank capacities, etc., are appended. A copy of the bulletin will be mailed to any interested person on request. Published by the General Machinery Co., Limited, 22 Mulock Avenue, West Toronto.

SWAN-HUNTER'S BIG SCHEMES.

Presiding at Newcastle, at the annual meeting of Swan, Hunter, Wigham Richardson and Company, the Wallsend shipbuilders, Mr. G. B. Hunter said they were proceeding further in the matter of internal combustion oil engines, and were constructing an interesting vessel to be named "Tynemouth," in which oil would be used to generate power which would be applied to the propelling shaft through electric motors.

COAST TO COAST.

Port Moody, B.C.—The E. J. Dodge Shipping Co., a prominent San Francisco concern, is now in communication with the Vancouver Board of Trade regarding Port Moody's harbor, depth of water and other relative matters with a view to establish the new line of steamships between Port Moody and San Francisco, the cargo coming from the South consisting of cement, and the return fleet bearing large quantities of lumber from the local mills. It is understood that the shipments will be unloaded at Port Moody's newly completed wharf, the only Dominion government wharf on the whole of Burrard Inlet.

Victoria, B.C.—At the present time the forest branch is particularly active in supervising the operation of the railway builders of the 1,890 miles of railway now under construction in British Columbia, every mile of the work now in hand having been gone over during the past few weeks and reports received as to conditions obtaining in the various districts. There are four stages in constructive operations along the railways over which a close supervision is exercised by the forest branch officials. The first is the putting in of the camp and roads. Then comes the stage of right-of-way clearing, followed by that of cutting construction timber and disposing of the slash. In the spring of the year, with the disappearance of the snow, last year's clearings, unless properly attended to at the outset, are likely to constitute a veritable tinder bed.

Washington, D.C.—When the parcels post system had been passed by the legislature the question arose as to the cheapest and most efficient means of delivery of parcels in the big cities. A board of expert engineers was appointed to inspect and report on the many different makes of motor delivery trucks at the recent New York motor show. After a thorough and exhaustive inspection of all the trucks there, they recommended the purchase of Kissel Kar trucks for this purpose, with the result that the United States purchased five Kissel Kar 1,500-pound delivery wagons for the parcels post service of Washington, D.C. These represent the first four wagons of the parcels post service in the United States. If the Kissel Kar reputation is maintained, they are the forerunners of a fleet of Kissel Kars in the service of the United States in all parts of the country.

Regina, Sask.—In view of the fact that there is a great need for additional water supply in the various cities in parts of Southern Saskatchewan, a commission has been appointed for the purpose of investigating the practicability of diverting the water in the Southern Saskatchewan River for domestic and industrial purposes. This commission, which is to be known as the Saskatchewan Water Commission, will be composed of Hon. Senator Ross and A. J. McPherson, chairman of the Highways Commission. The investigation is to be proceeded with as rapidly as possible and consistent with the importance of the project. J. McD. Patton, C.E., who recently resigned the position of superintendent of the city waterworks, is to work in conjunction with the Water Commission, having full charge of the collection of data that is now available in connection with this work.

Victoria, B.C.—Much activity is now going on at Ogden Point, the scene of the new breakwater, which will give Victoria an artificial outer harbor capable of accommodating an enormous fleet of vessels. Heavy blasting is now being done and much rock has been removed by the big charges The contractors will level the land there down to three feet below the roadbed. As the greater part of that section is rock the work will consume some time. Most of the rock will be used in the filling-in work. The contractors who are building the offices for the Dominion inspectors and engineers, Sir John Jackson's employees and various other

offices have almost completed their works and Ogden Point resembles a small settlement. The contractors are greatly favored by having a natural bay close to the Point. The scows are run in at high tide, and as the water recedes they are left high on the sand.

Edmonton, Alta.—Between twenty and thirty elevators will be built, and put into operation by the Alberta Co-Operative Elevator Company, working with government assistance, in time to move the present season's crop.

Toronto, Ont.—The report of Mr. J. F. Whitson, commissioner in charge of the $5,000,000 grant to New Ontario, has been presented to the legislature by Hon. W. H. Hearst. Last year Mr. Whitson spent $208,446 out of the fund and cut or improved 253 miles of road. This year he proposes to spend $1,000,000. Last year the construction was confined entirely to the district of Temiskaming, but work for the current season will be carried out in the districts of Rainy River, Kenora, Thunder Bay, Sudbury, Algoma, and Sault Ste. Marie and Nipissing, as well as an extension of the roads started last year in Temiskaming. Trunk lines are recommended in the Fort William and Port Arthur districts along the lines of the Grand Trunk Pacific and Canadian Pacific Railway, and in the district of Sudbury there will be trunk roads to agricultural and mining sections west and north of the town and north-east through the Wahnapitae Lake district, and a mining road north to the Shining Tree district.

Winnipeg, Man.—The government experiment station at Estevan, for the purpose of demonstrating the commercial possibilities of lignite coal, is now in the initial stages of construction, and it is expected that before many weeks Professor Darling, the leading recognized authority on this mineral in the United States, who has been placed in charge of the investigation by the provincial government, will have proven, through his experimental work, that the extensive coal deposits of the Souris Valley form the most important source of power in the southern portion of the province. The result of the recent exhaustive investigation into this subject, conducted by R. O. Wynne-Roberts, was that lignite coal is now being used extensively in many parts of the world as a fuel and power producer. The matter of installing a gigantic power plant in the near vicinity of Estevan, on the proof of the commercial feasibility of the scheme, is now in the hands of New York financiers, and the money has been found to finance the proposition immediately the tests are completed.

Ottawa, Ont.—That the work of bringing water to Ottawa from the Gatineau Hills will be completed in two years, or in three at the outside, is the statement made by Mayor Ellis. The surveys and preliminary engineering work required for the calling for tenders will be proceeded with at once. Part of this work will be done by the government. The Department of the Interior has never had surveys made of the Gatineau district, though these surveys have to be made sooner or later. Hon. T. W. Crothers, acting Minister of the Interior, stated that the geodetic survey branch of the department will commence its surveys of this district at once. The city is employing a representative of Sir Alexander Binnie & Son's firm, and Mr. J. B. McRae, of Ottawa, to do the required preliminary engineering work, and will also undertake any other survey work which is essential for the proposed water supply, and outside the work of the geodetic survey. It is intended that the geodetic survey should co-operate with those employed by the city. In this way it is expected that the requisite survey and preliminary engineering work will be completed this summer. This becomes possible only through the co-operation of the geodetic survey, so kindly promised by the acting Minister of the Interior. At least a year, and perhaps two, will be gained in this way.

PERSONAL.

MR. J. C. JOHNSTON has been appointed engineer of Port Alberni, B.C.

C. H. TOPP, recently the consulting engineer of Victoria, has been appointed consulting engineer for the municipality of Saanich.

FRANK C. ASKWITH, C.E., who has been acting city engineer since Mr. Ker resigned, has been appointed assistant city engineer of Ottawa.

MR. A. W. DOW, Chemical and Consulting Paving Engineer, New York City, on March 11th delivered an illustrated lecture on the "Manufacture of Wood Paving Blocks," before the graduate students in highway engineering at Columbia University.

MR. NELSON P. LEWIS, M.Am.Soc.C.E., Chief Engineer, Board of Estimate and Apportionment, New York City, on March 13th delivered an illustrated lecture on "Methods of Paying for the Construction of Street Pavements," before the Graduate Students in Highway Engineering at Columbia University.

H. F. McDONALD, B.Sc. (McGill), and C. D. BROWN, B.A. Sc. (Queen's), have opened offices at No. 904 Confederation Life Building, Winnipeg, as consulting engineers and land surveyors. H. F. McDonald has for the past three years held the position of townsite surveyor to the Canadian Pacific Railway. C. D. Brown recently resigned the position of right-of-way surveyor to the same company. Both Mr. McDonald and Mr. Brown hold surveyors' commissions for Manitoba, Saskatchewan and Alberta and intend paying particular attention to subdivisions and town planning in the Western provinces.

OBITUARY.

GEO. H. PEDLAR died suddenly at his home in Oshawa while preparing for a business trip to Chicago. Deceased was president and manager of the Pedlar People, Limited, a company he established over 50 years ago, and which through his ability, became a flourishing concern, having at present offices in Toronto, Montreal, Ottawa, London Chatham, Winnipeg, and Vancouver. He was 70 years of age, and was throughout his busy life actively interested in public and social affairs and a generous giver to all charities.

The Late Geo. H. Pedlar.

CALGARY BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a largely attended meeting of the members of the Canadian Society of Civil Engineers, resident in or near Calgary, held on the evening of the 12th instant, it was resolved to proceed with the organization of a branch in Calgary. Temporary by-laws were adopted, modelled largely on those of the Victoria Branch, and the following officers were appointed to serve until the branch is formally organized, viz.: H. B. Muckleston, chairman; P. M. Sauder, secretary-treasurer; F. H. Peters, A. S. Dawson and E. L. Miles, executive committee. It was decided to secure suitable quarters for a club and reading-room in the near future.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO SECTION).

The fifth regular meeting of the Toronto Section will be held at the Engineers' Club, 96 King Street West, at 8 p.m., on Friday evening, March 28th, 1913. Mr. F. W. Peek, Jr., of the General Electric Company, Schenectady, N.Y., will address the meeting on "High Voltage Engineering." This paper will deal with corona phenomena and insulation problems, as well as transient and voltage control, in connection with long distance high voltage transmission work. No mathematics will be used and the address will be illustrated with stereopticon views.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The local members of the Canadian Society of Civil Engineers will organize a branch and start a reading and club room in Calgary. The objects of this society are to facilitate the acquirement and interchange of professional knowledge among its members and to encourage original investigation. The membership of the branch will consist of honorary members, members, associate members, juniors, students, and associates of the Canadian Society of Civil Engineers.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Meeting of the Toronto Section will be held at the Engineers' Club, 96 King St. West, at 8 p.m., Friday, March 28th. Secretary, H. I. Case, 709 Continental Life Bldg., Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Décary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, April 3, 1913

Contents of this issue on page 531

The Canadian Engineer

An Engineering Weekly

RAILWAY SWITCHES AND TRACK LAYOUTS

BY J. L. BUSFIELD, B.Sc.*

In the past few years a great deal of attention has been paid to the design of railway switches and turnouts. It is not so very many years ago since railway engineers put in "any old thing" for a switch, whereas in these days of scientific refinement it is a subject which is dealt with on a proper mathematical basis. It is not the writer's intention here to deal with a number of abstruse mathematical calculations, but to give a general description of the construction of switches and their assembling in groups to give yard layouts, and the problems that railway men have to contend with in designing these layouts.

A brief description of the construction of a standard switch with the names of the various component parts is first necessary. Referring to Fig. 1, the switch is made up of two switch points "aa," a frog "b," two guard rails "cc," and the connecting or closure rails "d," the through rails "ee" are called the stock rails; "ff" are the points of the switch, "gg" the heel of the switch, "h" is the toe of the frog, and "i" is the heel. The distance from the point of switch "f" to the point of frog is called the "lead."

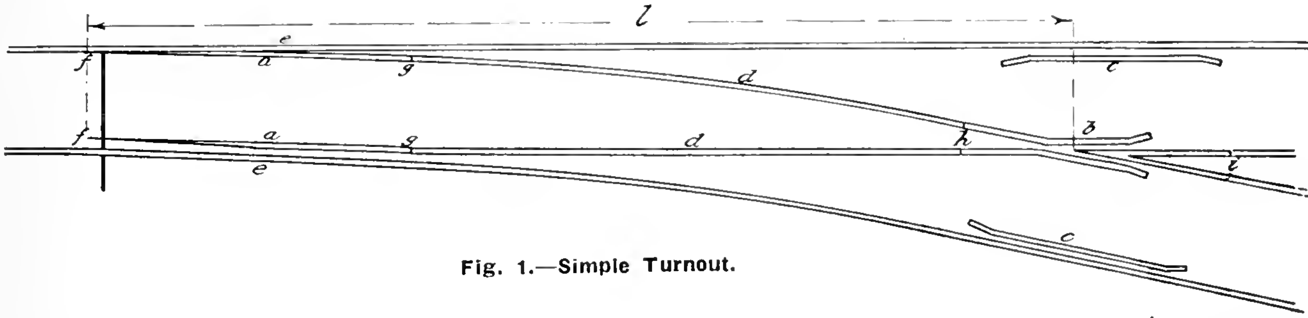


Fig. 1.—Simple Turnout.

Attached to the inside of the outer rails opposite the frog are two guard rails, varying from 8 to 12 feet long, placed there to control any side-play of the wheels passing over the frog, and so preventing the flanges mounting the rail instead of passing the point of the frog in the flangeways provided.

These guard rails are usually made from standard rail and are fastened to the running rail and the ties by special castings. The ends of the rails are splayed outwards to facilitate the passing of the wheel flanges into the flanges.

The two features which vary in different switches are the angle of the frog, and the lead. The frogs are always designated by a number, which denotes the inclination of the turnout rail to the main track, e.g., a No. 7 frog means that the two legs are inclined at an angle of 1 in 7. Now, the frogs in general use for ordinary railway work are as follows:

Frog No.	Angle.
6	8°–48 ft.
7	8°–11 ft.
8	7°–9 ft.
9	6°–22 ft.
10	5°–44 ft.

The No. 6 frog is only now being used in very exceptional cases, as it has been found to require too sharp a curvature to be able to accommodate the large equipment in general use; the No. 7 frog is also being largely discarded except on branch lines and freight tracks. The No. 8, 9 and 10 frogs are in general use, and in some cases frogs as flat as the No. 12 are used, such as for main line connections from a through main line to a local.

The switch points are usually made about 15 feet long, but a number of roads are adopting the 16-ft. 6-in. points in order to give an easier riding switch. They have a "throw" of 6 inches at the point, and at the fixed end there is a distance of 5½ inches from guage line to guage line of the two rails.

Now, after the frog and the points are selected they have to be connected with a curve on one rail and a piece of straight track on the other, or even a curve on both rails, as the case may be, but taking the case of one straight track and the curved turnout, the switch points and frog have to be spaced at such a distance apart that a curve of uniform radius will be tangential to the heel of the switch and the toe of the frog. The distance apart of the point of switch and the point of the frog (the lead) and the equivalent radius and degree of curve is given in the following table, for use with 15-ft. switch points:

* Assistant Engineer, Montreal Tunnel and Terminal Construction.

No. of frog.	Actual lead.	Equiv. radius.	Equiv. degree of curve.
7	60 ft.	410 ft.	14°– 0 ft.
8	66 ft.	573 ft.	10°– 0 ft.
9	75 ft.	702 ft.	8°–10 ft.
10	82 ft.	1,011 ft.	5°–40 ft.

This equivalent radius of 410 feet just about corresponds with the minimum radius that most standard railways are

Fig. 2.—Ladder at Angle of Frogs.

willing to adopt, even for spur tracks and sidings away from the main line, the large switching and main line engines being unable to cope with sharper curves without frequent derailments.

Whatever design for a layout of switches and tracks is considered, the three details given in the table above have to be borne in mind, i.e., the angle of the frog, the lead and the curvature.

The three commonest positions of the switch are in the simple turnout, the crossover and the "ladder." In the design of a crossover the piece of track between the two main

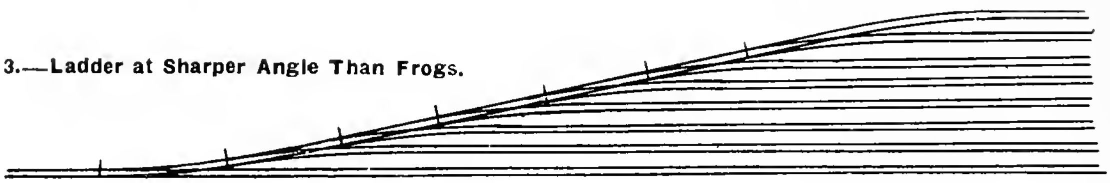


Fig. 3.—Ladder at Sharper Angle Than Frogs.

tracks and connecting the two frogs is always made straight and the distance in between the frogs is easily obtained, knowing the frog angle and the distance between track centres.

In the case of No. 10 frogs and 13-ft. centres between tracks this distance is 34 ft., thus making the total length of crossover 198 ft.

The design of a ladder requires more consideration, and conditions such as property limits, track capacity, etc., have to be dealt with, but if there are no such

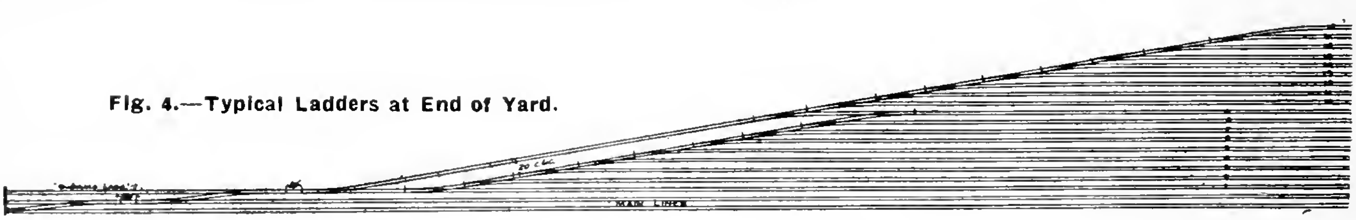


Fig. 4.—Typical Ladders at End of Yard.

limiting conditions a simple straight ladder can be laid out so that the ladder track is at the same angle with the yard tracks as the angle of the frog that is to be used in the switches, in which case the frogs are set at the intersection of the gauge lines of the two rails, as is shown in Fig. 2. If the first frog in the ladder is located it is a simple matter to find the distances between all the frogs on the ladder, e.g., if No. 8 frogs are to be used, and the tracks are 13-ft. centres, the frogs will be 8 × 13 = 104 feet apart, so that if there are going to be, say, 7 tracks connected to the ladder the last track will be about 700 feet shorter than the first. This is usually rather a serious situation as it is almost always desirable to get the longest track possible, or at any rate to get the tracks as nearly the same length as possible, but it is readily seen that in order to make the last track longer it is only necessary to increase the angle which the ladder makes with the main yard tracks, the effect of this being to reduce the distance between the frogs, which do not now point in the same direction as the yard tracks, and so have to be placed closer to the first track in order to allow room for the necessary curve between the heel of the frog and the tangent, as is shown in Fig. 3. Now, the maximum angle at which the ladder track can be placed is fixed in this way: the distance from the point of switch to the point of frog (assuming the use of No. 8 frogs) is 66 ft., the standard distance from point of frog to the heel is 9 ft., and the closest distance that the point of one switch can be placed to the heel of the frog of the preceding switch is 3 ft., to allow for the angle plates of the joint, thus we have the minimum distance between frogs is 78 ft., thus giving an angle of 1 in 5.2 for 13-ft. centres or 1 in 6.5 for 12-ft. centres. Using these figures in a yard of 7 tracks there would be an increased length in the last track of about 180 ft. and a proportional increase in the other tracks.

It is not usual in good railway practice to put more than 9 or 10 tracks on the one ladder, as this has been found by experience to be the maximum number that can be efficiently operated by one engine, except in special cases; for instance, where the tracks are used solely for storage purposes. Fig. 4 shows a typical arrangement of tracks with two ladders serving 18 tracks in all.

It is usual to extend the first track in the opposite direction to the yard, to make a switching lead, as shown in Fig. 4; this lead allowing switching engines to make up the various trains without encroaching on the main lines.

In some instances it is desirable to put in even steeper ladders than can be done by the methods described above, especially in cities and towns where land is valuable and must be occupied to the greatest possible advantage. In cases like this a ladder can be used, as shown in Fig. 5.

This ladder, although giving the advantage of longer tracks, has the disadvantage of having the switches on op-

posite sides of the main track, so that the switchmen have to be continually crossing and recrossing the track in front of the switching engine and trains.

The main ladder track has to be placed at such an angle to the yard tracks that there will be enough curvature between the heels of the frogs in the ladder track, and the straight tracks to which they connect, to allow a second switch to be placed within this curve. The primary switches in the ladder track are directly connected to each alternate track, and the secondary switches pick up the remaining tracks. The typical layout in Fig. 5 shows the method better than it can be described. A certain amount of variation is possible in the angle of the ladder track, but it is limited by the lengths of the switches, the frog angles and the track centres.

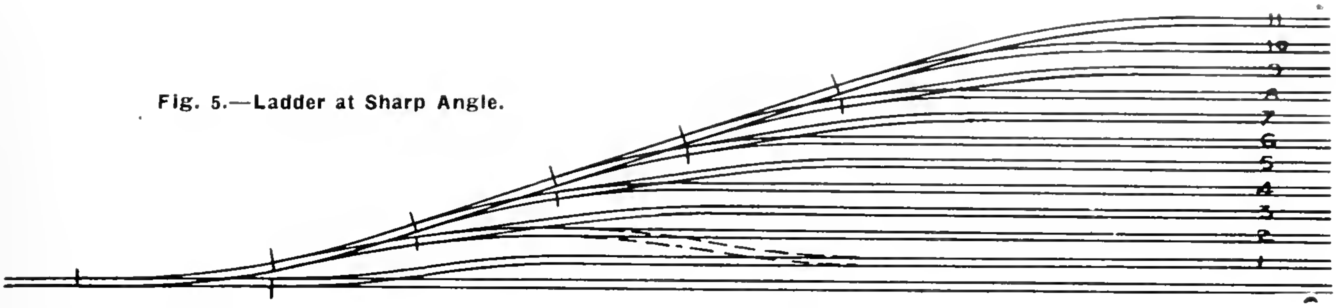
As will be seen from the plan of this type of layout, it is not possible to connect the first, or No. 1 track to the ladder, but this difficulty is easily overcome by running it into the main line, or else, as shown dotted, from No. 2 track.

It frequently happens that the ladder track at the end of a yard cannot be located where the main tracks are on a tangent; in which case the ladder track has to be built to the same curvature as the main line, but if the yard is on the outside of the curve, it becomes difficult to lay down the switches without excessive curvature and the limit is reached when the curvature of the switch added to the curvature of the main line reaches the maximum permissable curvature.

Modern freight classification and storage yards are very often designed so that all the tracks forming one "set" are the same length, thus reducing the difficulties of operating the yard through having a number of tracks of greatly varying lengths. A typical layout for a yard of this nature is shown in Fig. 6, giving two main yards for the sorting of inbound and outbound freight, with a space between them for storage, caboose, and engine tracks, yard offices, etc.

A type of combined switch and crossover, known as a slip switch crossing, is shown in Fig. 7, and is being largely used in places where great flexibility of movement is required. As will be seen, this crossing will give two alternate routes for a train coming in any of the four directions. In construction it is a regular diamond crossing, with the sides connected with switch points and closure. It cannot be conveniently used for tracks which cross at a sharper angle than 1 in 7 because the switch points, frogs, guard rails, etc., become too crowded together to permit of their proper construction.

Fig. 5.—Ladder at Sharp Angle.



In a slip switch of this nature the movement of all the points is made by one lever being placed at the centre of the crossing, but the use of this crossing is not considered very advisable except in yards with interlocking apparatus, owing to the increased liability to accident through two trains coming together, either "head on" or "sideswiping."

These slip switch crossings have enabled a design to be made for track layouts which is now being used in various forms in general large passenger terminals. The general idea of this layout is shown in Fig. 8, and it will be readily seen that great flexibility of train movement can be obtained, as either an incoming or outgoing train can keep to its correct track practically to the end of the platform to or from which it is bound. For instance, an outgoing train from platform 7 will take the switch to the right at the point "b" and thus be on its own right-hand track, and be independent of trains arriving at the platforms beyond No. 7. Similarly an incoming train will keep to the right-hand track as far as possible and only cross over to its own platform track as close to it as possible. The switches marked "b" in Fig. 8 are slip switch crossovers similar to that shown in detail in Fig. 7, but those marked "a" have the connecting switch on the lower side only, so are "half slips."

This type of double ladder with slip switches is rapidly coming into use in terminals where a large number of trains are handled, as it does away with a great deal of the congestion that is liable to take place through one train having to wait outside the terminal while another one is just leaving. This leads to delays, one delay leads to another, and the working arrangements of the whole terminal are upset.

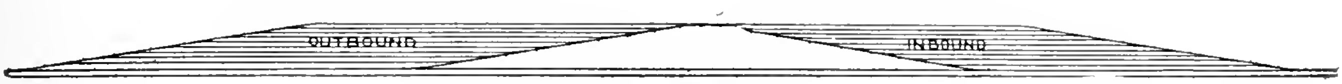


Fig. 6.—Parallel Ladders.

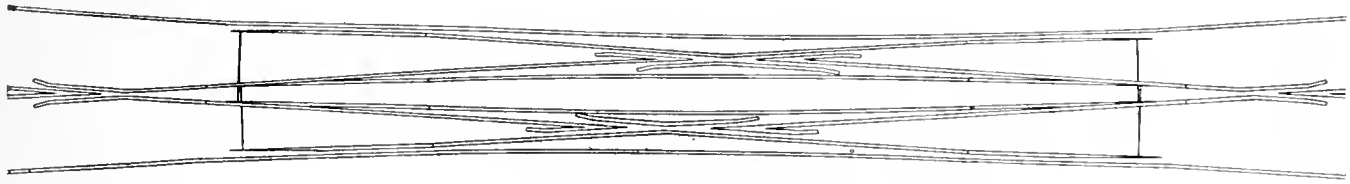


Fig. 7.—Slip-Switch Crossing.

whereas the double ladder permits the greatest number of movements either from one platform to another or of the main line trains, to be made without interference. A layout of this nature can only be economically used where an interlocking plant is in operation.

In main line work refinements have to be made in the switches to make them easy riding, such as the use of longer switch points, and spring frogs. The latter are made with one arm pivoted in such a way that ordinarily the main line rail is continuous, but when the turnout is being used the wheel flanges of the cars push this arm to one side, against the pressure of a strong spring.

On the railways in Great Britain even greater refinements are carried out with switches, to meet such conditions as are often obtained at junctions between stations where trains will frequently pass from the main line to the branch at as high a speed as 60 miles an hour. To meet these requirements the switch points are made very much longer and the whole switch is constructed on the principle of a spiral curve.

Great strides have been made in this subject during the past years, but even now it is quite possible to see yards with a jumble of switches at their extremities which might have been made into orderly ladders, and with "stub" switches which should be on the scrap heap; but these will all no doubt be replaced in the course of a few years with the neat and efficient layouts that are now in general use in modern track construction.

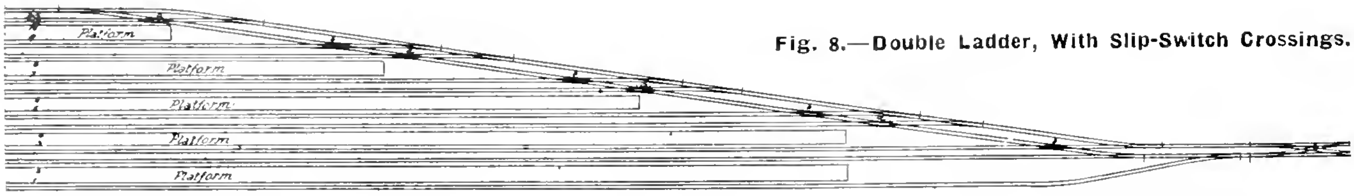


Fig. 8.—Double Ladder, With Slip-Switch Crossings.

SEWER CONSTRUCTION.

The laying of sewer pipe by contractors in treacherous ground of the quick sand type usually means pecuniary loss for the contractor if he was unaware, at the time of making his bids, of the soil of the above type he would encounter. A description of the troubles and difficulties of this kind unexpectedly run into is given in a paper presented before the Iowa Engineering Society, by C. P. Chase, and reads as follows:—

A contract was let in October, 1910, to Mr. C. R. Nichols, embracing 5½ miles of 8-in. to 15-in. pipe sewers, with manholes and flush-tanks, and a reinforced concrete septic tank with dosing chambers and sand filters.

It was expected to begin work at once, but the contractor was busy and let it go over winter. Conditions early in 1911 were ideal; but the contractor failed to begin, though constantly urged. At last, in July, 1911, work was begun on the disposal plant by a sub-contractor and the grading done and excavation made for the tank. Here the contractor, tied up by other affairs, abandoned the work.

The council gave notice to the bonding company to take up the work, and very shortly it came forward and agreed to complete the job. The contract was placed in the hands of the Lytle Construction Company, of Sioux City, which immediately began operations. The first trenching machines steamed up on Aug. 20, 1911, and conditions seemed to be favorable for completion that season.

In the deepest cut of some 21 ft. the machine cut to grade with no bracing and ditch dry as a bone. A large number of laterals on the east side were built, with cuts from 7 to 20 ft., with an occasional brace, the machines making in some instances as high as 650 ft. in one day on a 6 to 8-ft. trench. The laterals were nearly in before cold weather, but in the meantime, on the other branch of the main sewer, something had happened. As will be remembered, 1910 and 1911 to the fall of the latter year were very dry: this was especially true around West Liberty. A rain of several days came about Oct. 1, and the dry ground in 48 hours was filled with water, there to remain.

Quicksand.—In a recent English lawsuit a lawyer described a certain quicksand that had resulted disastrously to his client as "an oily, slithery, nasty mess, where men would speedily sink to their death if not rescued." There you have West Liberty. Molasses, soft glue, or crude tar come nearest. By various sewer men it was designated as quicksand, floating clay, sea mud, boiling sand, and worse. I would designate it as a silt deposit of some ancient lake bed. It varied from a fine, silty sand to a molasses-like mud, in which men frequently sank to their hips and were pulled out with ropes, and it would go anywhere that water would.

The first encounter with this was fought out in the usual way, with hand-driven sheeting afterward removed. One block about 300 ft. long, put in in this way, was clear and in good shape when finished; later the sides settled and the whole line was heaved out of line and grade and nearly every pipe crushed. The various ordinary expedients of sewer building were tried without much success.

First a small section was taken out by hand, driving the sheeting down as the excavation proceeded; when to grade short ship lap was driven about 2 ft. below grade and left 2 ft. above. Straw, cinders, stone, brickbats and other material simply floated away, the great trouble being that after the pipe was laid the bottom of the trench would raise up from pressure of the sides and break open the joints or even crush the pipe.

It was seen that although expensive, more strenuous methods must be adopted, and that perfectly tight sheeting must be used, of sufficient strength to hold the side pressure and that it must be secured and left in. It was also found to be impossible to depend on hand driving. An Arnott hammer and a proper outfit were secured. To prepare for sheeting, the ditch was opened with a trenching machine as deep as the banks would stand, which was from 6 to 9 ft., much better success attending machine digging than hand digging. Then 2 x 12-in. tight sheeting was driven about 3 ft. below the grade of the flow line of the pipe, thoroughly cross-braced and spiked. It was allowed to remain in the trench. Any attempt to remove the sheeting was attended with almost immediate disaster.

Two methods of placing and driving the sheeting were employed. In both cases the excavation was carried down 6 to 9 ft. with a trenching machine, temporary braces being set to hold the clay banks until the stringers could be placed.

In the first method a set of 4 x 6-in stringers was placed at the bottom of the machine-dug trench, 2 x 6-in. stringer being placed next to the bank and separated from the 4 x 6-in. stringer by a 2-in. block, much care being taken to have them set plumb, otherwise the sheeting would drive crooked. A similar set was placed about 3 ft. below the surface of the ground and the sheeting driven between the 2 x 6-in. and the 4 x 6-in. sets. A timber frame 16 ft. high was constructed on a platform wide enough to span the trencn, and the hammer suspended on a trolley running on a 7-in. I-beam set transversely to the trench at the top of the frame. The platform was build on skids parallel with the trench, so that it could be easily moved forward as the driving progressed. The hammer was operated between two pairs of guide rods made of galvanized iron pipe, a gasoline engine and hoist being used. With this method and equipment an average of about 60 pieces of 2 x 12-in. timber, 18 ft. long, could be driven per day at a cost for labor of 50 cents per lineal foot of trench and a total cost for sheeting of about $3.20 per lineal foot. It was hard to keep the outfit upright and steady, and this reduced considerably the driving power. Only one plank could be set on each side of the trench at a time, making it necessary to move every foot, which was impracticable and too expensive.

In the second method blocks were set between the 4 x 6-in. stringers and the 2 x 6-in. stringers omitted. The steam hammer was handled by a derrick with a 20-ft. boom, the guide rods in this case being made fast to the hammer, and sliding through iron loops fastened to the end of the boom. The derrick was erected on a platform similar to the one described above, and in such a way that the foot of the derrick was over the centre of the trench. In this way about 34 pieces of sheeting could be driven from one position. The derrick was then moved forward and the driving continued. Laborers set up the sheeting ready for the driver as soon as the stringers were in place, so that the hammer could be kept constantly at work. With this method the number of pieces driven per day was increased about 30 per cent., with a corresponding decrease in cost.

Removing Material.—The quicksand was taken out in buckets of ¼-cu. yd. capacity. To handle the buckets, two derricks made of 6 x 6-in. timbers, with 20-ft. booms, were erected on opposite ends of a platform made to span the trench. A four-post frame made of 6 x 6-in. timbers properly braced held the derricks in place. On the platform within the frame a 4-h.p. gasoline engine furnished power for the hoists, which were so arranged that one man could operate both derricks. This apparatus was employed to handle the steam hammer, and when hitched to a scraper was also used for backfilling. The blocks were so arranged that in raising a full bucket from the trench its weight pulled the boom around to the side of the trench where the bucket was to be emptied. Seven men were ordinarily sufficient to operate this device, doing more and better work than 14 formerly accomplished by hand. Without it or something similar it would have been almost impossible in the worst places to make any progress against the quicksand; for in spite of tight sheeting, carefully driven, the sand ran in through the smallest cracks and boiled up from the bottom. Occasionally after half a day's work there were no results apparent in the trench.

Preparing Bottom.—With the sheeting in place, and the trench excavated, special methods had to be devised to prepare for pipe laying. Cinders, straw, brickbats, piling and concrete were experimented with, and at last concrete was chosen—first, to keep the sheeting from pressing in and crushing or disturbing the pipe, and, second, to obtain a pipe bed. The concrete placed one day was not used to lay pipe on until the next. Half of the diameter of the pipe was buried in concrete to distribute the weight and prevent crushing.

In some places where concrete was being placed for foundation the sand boiled up through the concrete before it had time to set and rendered it useless. To overcome this, inch boards were laid lengthwise in the bottom of the trench the full width and nailed together. They were then worked down through the sand and water as far as they would go, sufficient excavating having been done to permit the boards to be worked down to a point 6 or 8 in. below grade. The sand and water were then cleaned off the boards and the concrete placed. The time saved in this way more than paid for the boards, and a much better foundation was obtained.

Of all the equipment which the contractor had on the work the steam hammer and the derrick device for handling wet excavation gave him the best returns on the investment for plant.

Occasionally there would be an oasis in this sea of antediluvian mud where a good bottom could be secured by mixing cinders with it. This seemed to work where it was sticky, with clay predominating. It would fill up and bind, but if fine sand predominated, cinders were useless.

All pipe was eventually covered with dry earth and the fill was compacted by tamping to a depth of several feet.

Railroad.—Where the 15-in. main crossed the Chicago, Rock Island and Pacific right-of-way an attempt was made to tunnel the main tracks; but the sand was so bad that it was finally found necessary to drive a temporary bridge of 15-ft. span under each of the two main tracks and make the excavation in open cut. Under the stringers of the bridges for a space of several feet horizontal sheeting was set, and below this 2 x 8-in. sheeting was driven down below grade by hand. Outside the main tracks steel sheeting was driven and later pulled, using a 6-ton Triplex block. Cast-iron pipe was used across the right-of-way, and it was not thought necessary to leave sheeting in the trench. As the sand offered no foundation for the cast-iron pipe, brickbats and concrete were placed under the joints. The excavation was carried down below grade, a wagon load of brickbats dumped at the place where the joint would come, and about one-half or three-fourths of a cubic yard of concrete dumped from large buckets on the brick. So much sand was taken out at this place that the banks settled considerably, more than 1 ft. at one point. This line of sewer, however, showed up well on final inspection.

The contract, which ordinarily would take six months, was completed in November, 1912, and much credit is due to the contractor for the gameness with which he stuck and finished the work.

ROAD GRANTS IN ENGLAND.

Considerable dissatisfaction exists among highway authorities in London, England, at the manner in which the Road Board is dispensing financial assistance for the repair of roads damaged, chiefly by heavy motor traffic. The board hinted at the outset that it was prepared to make grants and loans to the authorities in the metropolitan police area up to the amount of £250,000. But it seems that no authority can get a grant unless it is itself prepared to spend three or four times as much as the grant, and is considered that this policy is a direct incitement to local bodies to spend more money than the circumstances of the case demand. Road board grants, it is claimed, should be unconditional, and that local authorities should not be forced to spend large sums out of the rates for the special benefit of motor traffic. So strong is the resentment of the authorities on this policy that the subject is to be raised in parliament at the first favorable opportunity.

STREET PAVING IN ENGLAND.

The Metropolitan Paving Committee, of London, England, have recently issued their tenth annual report relative to paving work compiled from information furnished by the engineers to the authorities concerned. As this information is very complete in its way, it may be of interest to Canadian engineers as regards cost comparisons. It should always be remembered that our more rigorous climate and the difference of the labor wage, lessens the value of this report as far as Canadian practice is concerned. We are of the opinion that a perusal and study of its contents is nevertheless both advisable to all interested in road building.

The brief summary of the work done is taken from The Surveyor, of London, England, February 21st, 1913. The prices mentioned have been changed to the decimal system of coinage to suit our Canadian readers.

Principal Kind of Paving Laid.—The bulk of the paving laid down in the districts mentioned in the returns during the year appears to have been creosoted soft wood, although in some instances other kinds of paving predominated. Large areas of tar-macadam were laid in some districts, principally in limited traffic residential and business streets, while a large amount of tar-spraying has also been undertaken.

Foundation.—In some boroughs a foundation of Portland cement concrete 9 in. thick (in one case 12 in.) has been adopted, while in others a 6-in. foundation has been deemed sufficient. There is a decided tendency to increase the thickness of concrete foundation, owing to the detrimental effect of heavy motor traffic.

Effect of Motor Traffic.—Motor traffic is considered to be detrimental to macadam-paved roads, and the majority of the borough surveyors are of opinion that motor traffic has increased the cost of the upkeep of the roads.

Saving on Tar-sprayed Roads.—Considerable saving continues to take place in those boroughs where the tar-spraying of macadam roads is largely undertaken. From the appended information it will be seen that a very considerable saving has been effected in the boroughs of Fulham, Greenwich, Hammersmith and Wandsworth in the cost of scavenging, watering and maintenance of highways since the adoption of the system of tar-spraying macadamized roads. It is, moreover, generally agreed that a great improvement in the road results from tar-spraying.

The returns sent in during the past year have been put in tabulated form, and may be briefly summarized as follows:—

Greenwich.—Some 3,600 super. yds. of tarred macadam, 4 in. deep, were laid in this borough. The macadam was consolidated with the steam roller and laid on an old foundation, the subsoil being gravel. The cost of laying per yard super. was 79c. without foundation, the work being carried out by the local authority. The surveyor mentions that 47,227 super yds. have been tar-sprayed in the borough at a total cost of $2,258.

Hammersmith.—In Stamford Brook Road tar-macadam, composed of Trinidad Lake bitumen and granite mixed, 3 in. thick, with a sealing coat of refined Trinidad Lake bitumen, was laid on a foundation of old macadam at a cost of 90c. per yard super. In another thoroughfare, with limited traffic, tarred-slag macadam, 3 in. thick, was laid on an old foundation at a cost of 67c. per yard super. In this borough 275,164 super. yds. have been tar-sprayed at a cost of $2,931.11.

Hampstead.—Hard and soft wood, lithofalt block paving, lithomac paving and tar-macadam were laid in this borough during the past year. The 8-in. by 3-in. by 4-in. creosoted deal blocks were laid with close joints run in with a mixture of boiling pitch and creosote oil, grouted with Portland cement and top dressed with fine shingle on an old 6-in. foundation broken up and a new Portland cement foundation 9 in. thick, including 1 in. floating formed. The foundation was laid by the local authority, the paving by a contractor at a cost of from $1.36 to $1.38 per yard super. without foundation. The 4-in. Jarrah blocks which this paving replaced had been down for eleven years in these heavy traffic roads. In Heath Street, where the traffic is limited, these blocks were laid in the same manner on an existing foundation made good and refloated with Portland cement and sand, at a cost of $1.70 per yard super., including the work of remaking the foundation. The 5-in. deal blocks which this paving replaced had been down nineteen years.

In Finchley Road, a heavy traffic thoroughfare, 8-in. by 3-in. by 3¼-in. sectional Jarrah blocks were laid, the courses divided by fillets of ¾-in. in depth and 1/12 in. in thickness, the joints being filled in with a mixture of boiling bitumen. They were laid on an existing foundation made up to the proper level with Portland cement concrete, and refloated with Portland cement and sand at a cost of $3.29, including the cost of the work of remaking the foundation. The Jarrah blocks which this paving replaced had been down eleven and twelve years. The surveyor states that this sectional block paving has proved very satisfactory after an experience of seven years; the wear is smooth and even, and there is no corrugation of the paving as in ordinary hardwood paving.

Lithofalt blocks, 9 in. by 4½ in. by 1¾ in., were laid in Belsize Road, where the traffic is considerable. They were laid on wet floating, on an existing foundation, made up to suit the new paving. The blocks were supplied by a contractor, and the work was executed by the local authority, the cost per yard super. being $1.72 with foundation.

Lithomac paving, 2 in. in thickness, was laid in College Crescent, where the traffic is considerable, at a cost of $1.23 per yard super. with foundation.

Holborn.—Most of the paving laid in this borough consisted of compressed rock asphalt 2 in. thick, the Portland cement concrete foundation being, in nearly every case, 9 in. thick. The rock asphalt was compressed with heated pelons, the cost per yard super. varying from $2.47 to $3.35 with foundation, and $2.19 to $2.25 without foundation. This paving has worn well. Some Trinidad Lake asphalt macadam, 3 in. thick, was laid at a cost of $1.15 per yard super. without foundation.

In Chancery Lane, where the traffic is considerable, creosoted Swedish deal blocks, 3 in. by 9 in. by 5 in. have been laid in pitch grout finished in cement, joints 1/10 in. in thickness, on a Portland cement concrete foundation, 9 in. to 11 in. in thickness, at a cost of $3.22 per yard super. with foundation, and $1.85 without foundation, the annual cost of maintenance per yard super. being 24c.

Kensington.—The return from this borough contains particulars of a new description of paving—namely, camphor wood blocks, 9 in. by 3 in. by 4 in., grouted tar pitch and cement, and laid on a 6 in. Portland cement concrete foundation at a cost of $2.73 without foundation.

Creosoted deal blocks, 8 in. by 3 in. by 4 in. or 4½ in. or 5 in., were laid, grouted tar pitch and cement on a 6-in. Portland cement concrete foundation, at a cost of from $2.23 to $2.50 with foundation, and $1.63 to $1.80 without foundtaion. In Notting Hill Gate the wood paving which this paving replaced had been down twelve years, and in residential thoroughfares the paving replaced wood paving which had been laid from sixteen to twenty years previously.

Kensington asphalt clinker blocks were laid in residential thoroughfares by the local authority.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz, M.E.*

At a recent meeting of the New England Association of Gas Engineers, Prof. Ganz delivered the following interesting lecture on Electrolysis from Stray Electric Currents. Written in clear style and apparently free from the assumption that those reading are all highly versed in electric technology, it should be instructive and pleasant reading for all.

A Definition and Theory of Electrolysis.—Electric current may be conducted in two ways: First, by metallic conduction; and, second, by electrolytic conduction. Metallic conduction occurs when an electric current passes through a metal, and is characterized by the fact that no chemical change is produced in the conductor, the only effect being the production of heat. When electric currents, therefore, pass through metallic conductors, such as copper wires, rails, or pipes, they produce no change in these conductors except to raise their temperature. Under all ordinary conditions stray electric currents found on underground pipes

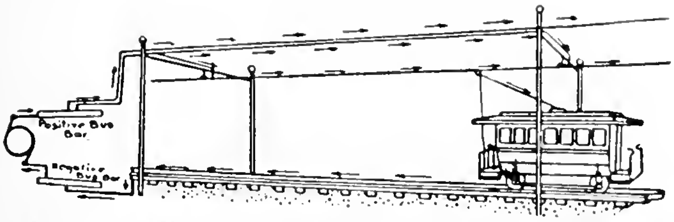


Fig. 1.—Diagram Showing Path of Current from Generator through Positive Feeders, Trolley Wire, Car and Rails.

are not sufficiently large to appreciably heat these pipes. Under abnormal conditions pipes may, however, carry stray currents of sufficient magnitude to produce heating at moderately high resistance joints.

Electrolytic conduction occurs when an electric current passes through an electrolyte, and is characterized by the fact that the electric current is transmitted by a corresponding transfer of ions in solution, with the production of chemical decomposition at the electrodes where the current enters and leaves the electrolyte. Electrolysis may, therefore, be defined as chemical decomposition produced by an electric current. Electrolysis is usefully applied in the arts for the refining of metals and for producing chemical compounds. The writer wants to discuss here the destruction of underground structures caused by electrolysis from stray electric currents which reach these structures.

Chemical compounds in solutions of water, constitute the ordinary electrolytic conductors. Pure water itself has such a high resistance that it may practically be considered a non-conductor. It is for this reason that an iron pipe full of ordinary city supply water does not have a lower resistance than the same pipe without water. Water is, however, readily made conducting by the addition of small amounts of salts, and conduction through water is, therefore, always electrolytic.

The following is a brief explanation of the theory of electrolytic conduction. When a salt is dissolved in water, some of the molecules separate or dissociate into two parts, one part having a positive electrical charge, and the other a negative electrical charge, and these parts are called ions. The metal parts (or the hydrogen) constitute the positive ions, and the acid parts the negative ions. For instance, copper sulphate, $CuSO_4$, when dissolved in water, dissociates into the positive metal ion Cu and the negative acid ion SO_4. An electric current is transmitted through an electrolyte by the transfer of these ions. The electrode by which the current enters the electrolyte is called the anode, and the one by which the current leaves is called the cathode. The metal or hydrogen (positive) ions travel in the direction of the current and carry positive electrical charges to the cathode, and these metal ions, called cations, are deposited upon or are liberated at the cathode. The acid (negative) ions travel against the current and carry negative electrical charges to the anode, and these acid ions, called anions, will corrode the anode if it is a metal which combines chemically with these anions. The cathode is not corroded. With an electrolyte of copper sulphate dissolved in water, a copper anode corrodes into copper sulphate and dissolves, while metallic copper is deposited upon the cathode. If the electrolyte is common salt dissolved in water, the anions are chlorine, and an iron anode would be corroded, the iron forming ferrous chloride; the cations are sodium, and these would decompose the water present and liberate hydrogen at the cathode. These examples furnish an illustration of the fact that the corrosive action of the current results in supplying the electrolyte with an equivalent of the amount of salt decomposed by the current, so that the electrolyte is continually replenished with salt and its electrolytic conducting power is thereby maintained. This salt will contain metal ions of the anode or hydrogen, and may be different from the original salt which started the action.

Street soils, when entirely dry, do not conduct electric currents. Under ordinary conditions, however, street soils contain considerable water with salts in solution, generally chlorines, and this makes them electrolytic conductors. When an electric current passes through soil it, therefore, does so by electrolytic conduction and by corresponding chemical decomposition at the electrodes. Where an electric current leaves an iron pipe for soil it corrodes the iron by this action of electrolysis. It has been claimed in the past that soils may conduct metallically; but this has been disproved, and it is now recognized that conduction of electric current through soil is always electrolytic.

The rate at which ions are liberated at the electrodes is proportional to the current strength. With an oxidizing anode, such as iron or lead, the mass of anode corroded by one ampere in 1 second is equal to the electro-chemical equivalent of the metal of the anode. This is 0.00029 gram for iron (ferrous). From this the mass of iron corroded by 1 ampere in 1 year is $0.00029 \times 60 \times 60 \times 24 \times 365 \times 0.002205 = 20$ pounds (approximately). The electrochemical equivalent for lead is 0.0010716 gram, and the mass of lead corroded by 1 ampere in 1 year is $0.0010716 \times 60 \times 60 \times 24 \times 365 \times 0.002205 = 74$ pounds (approximately).

The separation of the metal or hydrogen ion from the electrolyte in the cathode absorbs energy from the electric circuit and generally produces an electromotive force in the opposite direction to the current. The oxidation of the anode supplies energy to the circuit, generally producing an electromotive force in the direction of the current. If the oxidizing anode is of the same metal that is being deposited upon the cathode, and if the electrolyte is the same at the anode and cathode, then there is no resultant electromotive force due to the electrochemical actions, and the only electromotive force consumed is that due to the resistance of the electrolyte in accordance with Ohm's law, exactly as with a metallic conductor. If the metal deposited at the cathode is different from that oxidized at the anode, or if hydrogen is liberated at the cathode, or if the electrolyte at the cathode is not of the same composition or density as at the anode, then there will be a resultant electromotive force, which may be either

*Prof. of Electrical Engineering at Stevens Institute Technology.

in the same or in the opposite direction as the current. It has been assumed by some writers in the past that no corrosion from electrolysis can take place if the voltage between two metallic conductors in soil, such as between pipe and rails, is less than 1.5 volts, because this is the dissociation voltage of water. This, however, is entirely wrong, and it has been proven by many investigations, also by practical experience, that the amount of corrosion produced by electrolysis is independent of the voltage, except in so far as this determines the amount of current flowing, and that the smallest fraction of a volt can produce corrosion from electrolysis under suitable conditions, and this is now generally recognized by electrical engineers.

A large number of laboratory tests have been made to determine whether electrolysis is produced when an alternating current flows from a metal to an electrolyte; for example, from a pipe to surrounding soil. These experiments indicate that a slight amount of electrolysis may be produced by an alternating current, which is generally less than 1 per cent. of the amount of electrolysis produced by a corresponding direct current. It must be remembered, however, that, in the case of alternating current, electrolysis would be produced wherever there is a flow of alternating current between a metal and soil, while with direct current metallic anodes exist only at ½ the points where current flows between metal and electrolyte; namely, where current leaves the metal.

Sources of Stray Electric Currents.—Stray currents are electric currents which have leaked from grounded electrical distribution systems and flow through ground and through underground structures. Grounded telephone and telegraph lines produce electric currents through ground of such very small magnitudes that their effects upon underground piping systems can be neglected. Direct current, electric lighting systems, in which the distribution is on the Edison 3-wire plan, with the neutral conductor grounded, are in American practice provided with such large neutral conductors of copper that practically no stray currents are produced from such systems. This grounding of the neutral in Edison 3-wire systems is to serve as a safety measure, and is not for the purpose of using the ground to carry current.

The secondaries of transformers are also frequently grounded to underground pipes for the purpose of preventing a high and dangerous voltage from existing between the secondary circuit and ground. Such ground connections, however, do not produce flow of current from pipes to ground and, therefore, such grounding of transformer secondaries does not cause danger from electrolysis.

Electric railways, using the running tracks for return conductors, often produce comparatively large stray electric currents through ground, and these are the only sources of stray currents which need be considered in practice. Direct current is very generally used for such electric railways, and it is the common practice to supply current to the care from an overhead trolley wire or from a third rail, and to return this current to the power station through the running tracks, supplemented where necessary by return feeders. A single-trolley electric railway is shown diagrammatically in Fig 1, in which the path of the electric current, from the positive terminal of the generator through the circuit and back to the negative terminal, is shown. The running tracks consist of rail lengths about 30 feet long, and these are mechanically fastened together by fishplates which consist of steel plates bridging across the rail ends and bolted to both rails. Such fishplates, while mechanically fastening the rail lengths together, do not form good electrically conducting connections between the successive rail lengths. For this reason, copper wires or straps, called rail bonds, are generally used to bridge across the abutting ends of the rail lengths for the purpose of affording a good electrically conducting path between successive rail lengths. The two rails of a single-track road, or the four rails of a double-track road, are also generally connected together at frequent intervals by cross bonds so that the 2 or the 4 rails may be available for the return of current. Instead of using copper rail bonds, the rail ends are sometimes welded together, or soft steel plates are welded across each side of the abutting rail ends, thus forming both a strong mechanical and a good electrically conducting connection between the successive rail lengths. A well bonded railway track should have a conductivity not less than 80 per cent. of the equivalent conductivity of continuous rails. To give some idea of the relative conductivity of steel rails, it may be stated that a single rail, weighing 90 pounds per yard, which is a size commonly used where the traffic is heavy, has about the same conductivity as a copper wire 1 inch in diameter. Thus the 2 rails of a single-track line, or the 4 rails of a double-track line, laid with 90-pound rails and well bonded, afford a good conducting path for electric current.

In the simplest form of single-trolley railway, already shown in Fig. 1, the rails are connected to the negative terminal of the generator at the power station, and the only path for current to return to the power station is by way of the running tracks. If the running tracks are laid upon wooden ties above ground, with broken stone for road ballast, as is common on steam railroads which run on their own right-of-way, the rails do not come in direct contact with ground, and the return current will be practically confined to the running tracks. If, however, the running tracks are laid below ground so that the top of the rails is on the level of the surface of the street, as is common in cities, then the rails will be exposed for a considerable area to contact with soil. If the tracks are laid on a concrete base a considerable area of the rails will similarly be in contact with the concrete. Since both damp soil and damp concrete are under ordinary conditions conductors of electricity, part of the current returning through the rails will shunt from the rails through the surrounding soil, as is illustrated diagrammatically in Fig. 2. It will be seen that, with the usual connection of positive terminal of the generator to the trolley wire and the negative terminal to the rails near the power station, the current will leave the rails for ground at points distant from the power station, and return to the rails in the neighborhood of the power station, in its path back to the negative terminal of the generator. Since every electric circuit must be completely closed, all current escaping through ground must again leave ground to return to the dynamo so as to complete the electric circuit. When underground metallic structures, such as gas or water pipes, lie in ground in the path of these stray currents, and where these pipes have electrically conducting joints, such as lead-calked joints or screw coupling joints, current will flow from ground to such pipes and flow largely on such pipes in a direction towards the power station. In the neighborhood of the power station this current will leave the pipes to return to the negative terminal of the generator, as shown in Fig. 2.

In the negative terminal of the generator or negative bus-bar is connected to the rails, at points some distant from the power station by means of insulated negative return feeders, then, at such connection points, the rails will be rendered negative in potential to ground, and currents will tend to flow from underground pipes through ground to return to the rails in the neighborhood of these connections. Stray railway currents on pipes will, therefore, tend to leave these pipes to return to the rails in all regions where these rails are connected to return feeders.

It must be noted that, while ordinary soil is a conductor of electricity, compared with metals its electrical resistance is enormously high; for instance, the resistance between the opposite faces of a foot cube of ordinary soil may measure anywhere from 10 to 1,000 ohms, depending upon the amount

of moisture and the amount of salts in the soil, while the resistance of a foot cube of iron is equal to about 0.0000004 ohms for the resistance of a foot cube of soil, it is seen that soil has no resistance which is of the order of 250,000,000 times as great as a body of iron of the same dimensions; that is to say, the conductivity of iron is 250,000,000 times as good as ordinary soil. It would seem from this that current would flow almost entirely on the good conducting rails and none through the high resistance ground. Resistance, however, varies directly as the length and inversely as the cross-section of a conductor, and with the large surface of rails exposed to the ground, the cross-section of the path of the current through ground is enormously great compared with the cross-section of the path of the current through the rails. As a matter of practice it is found that where the rails alone are used for the return of current, frequently a considerable portion of the total current actually leaks from rails through ground.

From the above considerations it will be seen that the leaking of current from the rails of electric railways, producing stray currents through ground and on underground piping, does not constitute a source of loss to the railway company; as, for instance, would be the case with leakage of gas or water. On the contrary, by allowing the current to return by ground and underground pipes as well as by the trolley cars back to the power station produces in these rails a drop in potential; that is to say, points in the rails away from the power station have a positive potential with reference to the rails at the power station. Since potentials are measured relatively it is convenient to consider the negative terminal of the dynamo, which is assumed connected to the rails at the power station, as at zero potential. The distribution of potentials in the rails of a simple electric railway system, and in the underground piping, is illustrated in Fig. 2, in which convenient values have been assumed. It will be noted that the stray current causes the underground pipes to be negative to the rails at points away from the power station, and positive to the rails near the power station. It is also seen that the negative potential of the pipe, plus the drop on the pipe, plus the positive potential of the pipe, equals the drop in the rails. In the case assumed a potential difference of 550 volts is maintained at the power station; of this, 10 volts is lost in the trolley wire, 520 volts is used by the motors of the cars, and 20 volts is left to bring the current back to the power station. If the negative bus-bar and the rails at the power station are considered as at zero potential, the rails at the car in the assumed case will have a potential of + 20 volts. Thus, for practical purposes, the ground with its underground pipes is subjected to a potential difference of 20 volts, and the amount of stray cur-

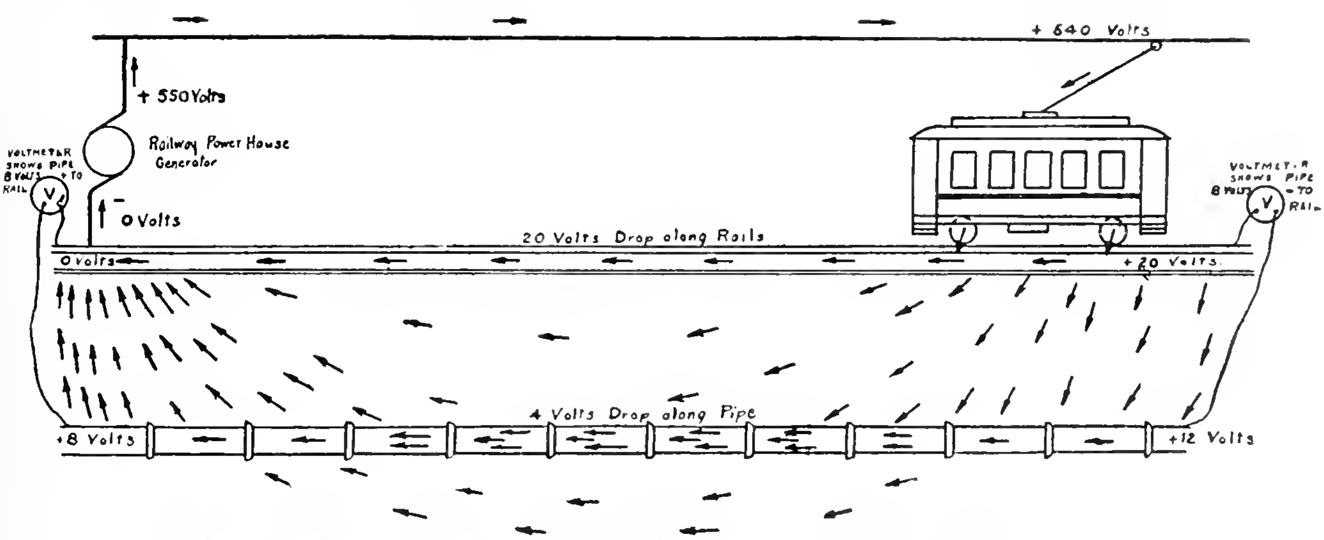


Fig. 2.—Diagram Showing Stray Currents and Assumed Resulting Potentials.

way of the rails, the total conductivity of the return circuit is increased, and the voltage loss in the return of this current is decreased, so that there is an actual saving of power for the railway company.

During the last few years alternating current has also been used in a number of cases for electric railways which employ the running tracks as a return conductor. Where these rails are in contact with ground stray alternating currents through ground are undoubtedly produced. As already pointed out, such alternating currents may produce electrolysis which varies up to 1 per cent. of that which would be produced by a corresponding direct current. However, no actual case of electrolysis from alternating currents from such railways has been reported, as far as the writer is aware. This may be due to the fact that alternating current electric railways in nearly all cases operate on long distance lines and on their own right-of-way, where they are away from underground piping networks. The author, therefore, does not feel warranted in drawing any positive conclusion as to the positive danger from electrolysis caused by alternating current electric railways where they operate within city limits.

General Effects of Stray Electric Currents on Underground Piping.—The current flowing through the rails from

rent produced is that due to these 20 volts. If the rails are laid in the usual way—that is, in contact with ground—the 20 volts in the rails will send some shunting current through the ground and through the underground pipe as shown in the diagram. Under the assumed conditions, there is a drop of 8 volts from the rails to the pipe near the car, a drop of 4 volts in the pipe itself, and a drop of 8 volts from the pipe through ground to the rails at the power station. It is, therefore, seen that it is the potential difference or drop in grounded rails caused by the return current which is the cause of stray currents through ground. Attempts should, therefore, be made to keep the potential difference or drop in rails as low as practicable, in order to keep stray currents through ground down to a minimum.

From the explanation of metallic and electrolytic conduction given in the first part of the paper, it will be understood that, where stray currents flow on underground pipes, they do no harm, except where they leave the pipes to flow to the surrounding soil. At such points corrosion of the iron from electrolysis will take place, and theoretically there will be a loss of 20 pounds of iron per year for every ampere of electric current leaving the iron. Some have assumed that, with the low densities at which current generally leaves un-

derground pipes, little or no corrosion is produced. A number of experiments made by the writer have clearly shown, however, that, even when current leaves iron for street soil at an extremely low density, corrosion is produced which is at least equal to, and frequently greater than, the theoretical amount. This increase of the actual over the theoretical amount is undoubtedly due to secondary chemical reactions set up by the action of electrolysis.

The underground structures which are most likely to be subjected to destruction from electrolysis, caused by stray electric currents, are piping systems and lead cable systems. From what has been said above it will be seen that oxidation or corrosion of such pipes or cable sheaths will occur wherever current leaves the pipe or cable sheath for ground. In the simplest case, illustrated in Fig. 2, current flows from rails through ground to the pipes at points distant from the power station, flows along the pipes and leaves the pipes to return through ground to the rails in the neighborhood of the power station. Where the current flows from the rails to ground the rails will be corroded, and where the current flows from the pipes to ground the pipes will be corroded. If the pipe line is a uniform electrical conductor, and the relative arrangements are as shown in Fig. 2, then the pipes will be corroded only in the neighborhood of the power station. If however, the pipe line is not a uniform conductor, as, for instance, if there are one or more high resistance joints in such pipe line, then the current on the pipe will shunt around these high resistance joints to produce oxidation or corrosion on one side of the joint. This action gives rise to joint corrosion, which is frequently found. Where there are two or more underground piping systems it also frequently happens that current shunts from one piping system to another through the intervening soil, producing electrolytic corrosion where the current leaves the pipe. Such shunting currents are often caused by accidental high resistance joints in one of the pipe lines, and such shunting may occur anywhere and without reference to the location of the railway power station. Where a direct-current trolley railway system passes through a town which has an independent piping network, and where the power station supplying the trolley line is in some other locality, then if stray electric currents are produced from the trolley line where it passes through the town, they will flow on the piping system, making this piping system positive to ground and to rails in the direction towards the railway power station and negative in the direction away from the railway power station. In this case electrolysis of the piping will be produced at the ends of the piping system towards the railway power station.

Where current leaves a wrought iron or steel pipe for ground, the oxide of iron resulting from electrolysis is diffused through the soil, and streaks of iron oxide can generally be found in the surrounding soil. Electrolysis of wrought iron or steel pipes usually results in pits, which eventually go entirely through the wall of the pipe. It has frequently been found in practice in the case of gas pipes that where a service of pipe lies in clay or other tightly packed soil, it may be pitted through in many places without giving any external sign of leakage, because the soil surrounding the pipe maintains it gas tight. When cast iron is corroded by electrolysis, the oxide of iron mixed with graphite usually remain in place leaving the outside appearance of the pipe unchanged. This material resulting from electrolysis of cast iron usually has the consistency of hard graphite, and can be cut with an ordinary knife. There have been many cases in which a cast iron main was carrying gas or water without any apparent leak, where a single blow with a hammer drove a hole right through the pipe. Here the electrolytic action had corroded the iron entirely through the pipe, and the oxide of iron had remained in place, and, together with the surrounding soil, had prevented the pipe from leaking. Whether or not the mixture of iron oxide and graphite resulting from electrolysis remains in place so as to maintain a pipe gas or water tight, depends upon the surrounding soil conditions. It is, therefore, seen that an underground piping system may be suffering severely from electrolysis without having given any outward sign of the damage. A physical examination with a test hammer is required in the case of cast iron piping to establish definitely whether or not it has been damaged by electrolysis.

For a given current leaving an iron pipe, there is practically no difference in the amount of iron destroyed between cast iron, wrought iron and steel The electrical resistivity of cast iron is, however, about 10 times as great as that of wrought iron or steel, and the usual lead joints in cast iron pipes also have a resistance many times greater than the screw-coupling joints usual with wrought iron and steel pipes. For these reasons a given voltabe drop through ground will cause a much smaller current to flow on a cast iron pipe than on a wrought iron or steel pipe, thus practically making cast iron pipes much less subject to electrolysis than wrought iron or steel pipes. The most frequent damage from electrolysis is found in the case of service pipes where these cross under trolley rails or other underground conductors to which they are positive. Examples of destruction of pipes by electrolysis which are often found in practice will be taken up later under the heading of "Damage and Danger Produced by Stray Electric Currents on Underground Piping."

(To be continued.)

RADIATION IN HOUSE HEATING.

By C. F. Smith.

For those interested in estimating the required radiation for residences the following formula and tables presented in an article in The National Builder should prove of value.

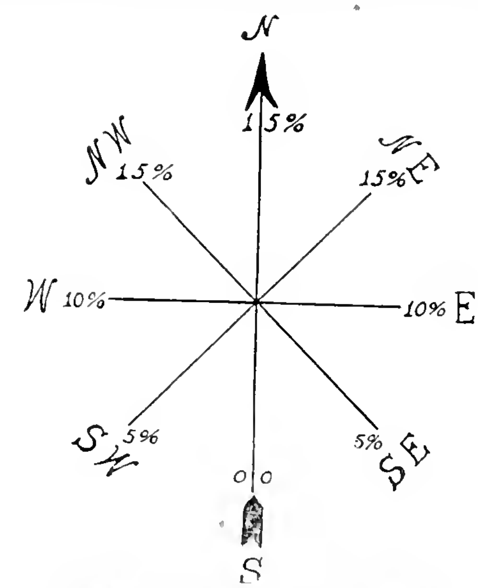


Diagram of Heat Units to be added for Different Exposures.

The formula is based on one change of air per hour in living rooms and bed rooms and three changes per hour in halls. In large living rooms or parlors, two air changes per hour, he states, should be provided for. Mr. Smith's formula is as follows:—

B.T.U. required $= W \times K + G \times L + C \times N \times T +$ a certain percentage for exposure in accordance with the following diagram.

In the formula:

W = net wall area.

K = a constant for different forms of wall construction in accordance with Table 1.

TABLE 1 (K)

	Heat losses in B. T. U. through walls of brick or frame, with differences in temperature of outdoor and indoor air of 40°F.	45	50	55	60	65	70	75	80
Brick walls, lathed and plastered inside.									
4 in. thick	12	13	14	16	17	18	20	21	22
8 in. thick	10	11	12	13	14	15	16	17	18
12 in. thick	8	9	10	11	12	13	14	15	16
16 in. thick	7.2	8.1	9	10	11	11.6	12.6	13.5	14.3
Clapboards or shingles	18	20	22	24	26	29	31	33	35
Clapboards, with paper	12	14	16	17	19	20	22	23	25
Clapboards, with sheathing	11	13	14	15	17	18	20	21	22
Clapboards, with sheathing and paper	9	10	12	13	14	15	16	17	18

All of above walls lathed and plastered inside.

TABLE 2 (L).

Heat losses in B. T. U. through windows and skylights, with differences in temperature of outdoor and indoor air of

	40°F.	45	50	55	60	65	70	75	80
Single glass	43.5	48	54.5	60	65.5	71	76	82	87
Double glass	24.7	27.8	31	34.1	37	40.2	43.4	46.5	49.6
Double window	18.4	20.7	23	25.3	27.6	29.9	32.2	34.5	36.8
Single skylight	46.5	52	58	64	70	75	81	87	93
Double skylight	19	22	24	27	29	31	34	36	39

G = glass surface (full size of window openings).

L = a constant in accordance with Table 2.

C = cubic contents of room.

N = number of air changes per hour.

T = a constant in accordance with Table 3.

If there is a cold space above or below the room, the surface area of the ceiling, or floor, should be multiplied by the constant R or S, as the case may be, as per Table 4, and the quotient added to the previous total.

TABLE 3 (T)

Specific Heat of Air, 0.2375

Initial Temp. Deg. F.	Weight of Air per Cu. Ft. Lbs.	B.T.U. to Raise 1 Cu. Ft. of Air 1° F	B. T. U. required to raise 1 cu. ft. of air from initial temperature (Col. 1) to final temperature of 60°F.	70	80	90	100	110	120	130	140	150
—20	0.0903	0.0214	1.716	1.931	2.145	2.36	2.575	2.789	3.004	3.218	3.432	3.647
10	0.0883	0.0209	1.468	1.677	1.887	2.096	2.305	2.516	2.725	2.935	3.144	3.354
0	0.0863	0.0205	1.23	1.435	1.64	1.845	2.05	2.255	2.46	2.665	2.87	3.075
10	0.0845	0.0200	1.003	1.204	1.405	1.605	1.806	2.006	2.207	2.408	2.608	2.809
20	0.0827	0.0196	0.786	0.982	1.179	1.375	1.572	1.768	1.964	2.161	2.357	2.554
30	0.0808	0.0192	0.576	0.768	0.960	1.152	1.344	1.536	1.727	1.919	2.111	2.302

TABLE 4 (R + S).

Heat losses in B. T. U. through ceilings and floors (the space above considered as 40° F. and below as 35° F., with differences in temperature of

Ceilings.	15°F.	20	25	30	35	40
Lathed and plastered	9.3	12.4	15.5	18.6	21.7	24.8
Lathed and plastered, double floors	2.7	3.6	4.5	5.4	6.3	7.2
Lathed and plastered, single floors	3.9	5.2	6.5	7.8	9.1	10.4
Floors.						
Single, not plastered	6.7	9	11.3	13.5	15.7	18
Single, lathed and plastered	3.9	5.2	6.5	7.8	9.1	10.4
Double, not plastered	4.7	6.2	7.8	9.3	10.9	12.4
Double, lathed and plastered	2.7	3.6	4.5	5.4	6.3	7.2

TABLE 5—ACTUAL VELOCITY OF AIR IN FLUE IN FEET PER MINUTE BY NATURAL DRAFT.

Hei't of Flue in Ft.	Temperature in Flue Above That of External Air, Deg. F 5	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150
1	24	33	42	48	54	60	67	75	81	88	95	101	108	113	118	122	127	132
5	54	75	93	108	120	135	151	168	183	198	213	228	243	254	264	275	285	299
10	78	108	133	153	171	198	216	247	266	288	308	326	342	358	374	388	404	419
15	93	132	162	189	210	231	264	297	326	354	379	393	420	438	456	474	492	513
20	108	153	189	216	243	264	306	342	376	409	435	460	483	504	525	547	569	594
25	120	171	213	243	270	297	337	384	414	444	475	507	540	564	588	613	638	663
30	132	189	234	264	297	324	372	420	460	498	533	565	594	620	647	673	700	726
35	144	204	252	285	321	351	402	453	489	525	561	597	639	669	698	726	755	783
40	153	219	267	306	342	375	429	483	532	576	616	652	684	717	750	780	809	838
45	162	231	282	324	363	399	456	513	564	610	652	690	724	759	794	829	864	887
50	171	243	297	342	383	419	482	541	595	644	688	728	765	801	837	873	908	937
60	189	264	324	373	420	461	529	594	650	703	751	795	835	876	919	958	994	1028
70	204	285	351	408	456	495	569	637	698	756	815	856	900	936	972	1008	1044	1083
80	219	306	375	435	485	530	608	687	747	809	866	918	965	1012	1060	1108	1148	1185
90	231	325	399	459	516	564	645	729	794	859	919	973	1022	1071	1116	1155	1196	1248
100	243	342	420	486	530	594	680	768	842	910	972	1029	1080	1134	1188	1233	1276	1325

EDMONTON TELEPHONES.

The city of Edmonton, Alberta, will spend in the neighborhood of $1,000,000 on extension work during 1913, the greater part of which will be cable work. It is the intention of this municipal department to build much underground conduit in both South Edmonton and North Edmonton, and there will also be considerable underground and aerial cable work. W. R. Griffith is superintendent of the department.

ENGINEERS AND GEOLOGISTS.

We take pleasure in publishing that portion of an address dealing with the general engineering profession, presented by Prof. H. E. T. Haultain, C.E., M.I.M.M., Professor of Mining, University of Toronto, before the recent annual meeting of the Canadian Mining Institute. It has caused considerable discussion, and as we mention, does not solely concern mining engineers, but applies generally. We are very sure every engineer will be glad to see Prof. Haultain taking up the gloves in an endeavor to give engineers who carry on material construction rather than interpretative theory, the credit that is due them. Quoting from this paper it states:—

There is another phase upon which I must touch, and that is the relation of the geologist to the community. Not only have the three last presidents of the Canadian Mining Institute been geologists, but the president of the American Institute of Mining Engineers is a geologist, the Dean of the Faculty of Applied Science of McGill is a geologist, the late renowned Principal of McGill was a geologist. Van Hise is president of the University of Wisconsin and Geikie is president of the Royal Society. We find geologists holding important public positions in all parts of the world, and holding them successfully and with distinction. The geologists are an ancient and honorable body. I can find no reference of slur or suspicion remaining attached to them. They have been clean and kindly men. Taking the geolgoists that I know personally I find them delightful men, agreeable companions and general favorites wherever they go. Of course, there is always the exception that proves the rule, but I believe you will all agree with me when I say that in general pleasantness the average of the geologists is higher than the average of most of the other groups of men with whom we come in daily contact. They are not only prominent in their scientific work, but they are prominent in the community, and the Canadian public at large accepts them not only as being of great importance to the State scientifically, but as being above the average good citizens.

In remarkable contrast to these public successes of the geologist, I find the condition of the engineer, not only the mining engineer, but the engineer in all branches. The engineer is doing the world's best work to-day. All that counts for prosperity and health and material growth is based on the work of the engineer. All that we are most proud of in this young nation is dependent upon the work of the engineer. The engineer exists in large numbers. Even in Ottawa there are more engineers than geologists. But we find very little public recognition of the engineer. We seldom if ever find him holding a public position of responsibility or honor outside of his immediate work. We have no engineers in Canada who are members of the Royal Society, and if we have one who has been knighted it is simply the exception that proves the rule. Why? How is it that the geologists beat the engineers to the high positions? Is it because their work is of greater importance to the State? Is it because their work is of a higher type? One would think so from the results. Is it not patent? Is it not obvious? But unfortunately the truth is not always obvious. Truth is oftener at the bottom of the well than prominent on the horizon. We must carry our analysis further. I submit that there is another and simpler reason. When we analyze the work and effort of the geologist we find it made up of two separate and distinct functions. The engineer's time and effort is devoted entirely to his engineering work. A part only of the geologist's time is devoted to the study of geology. A large part, and sometimes the larger part, is devoted to descriptions of his work, to publicity. One of their functions is that of the story-teller. From the beginnings of their existence they have been great story-tellers.

In fact, they have been the champion story-tellers of all time. Now, there is no doubt in my mind that some geologists, or near-geologists, will consider that this is another half-brick in poor disguise. But let us see what the story-teller has been to the community. When we go back to the beginning of things, that is, to the beginning of things for man, to about the time, let us say, of pithecanthropus erectus, the story-teller was beginning. He was almost the first luxury. Possibly man's first distinction was that he was a fire-using animal. Certainly about the same stage of his development he became a story-telling and a story-hearing animal, and the story-telling part was certainly more removed from mere animal than any other phase of his activities. Progress in all stages has been based largely on co-operative organization, and this came first with the fighting animal, but organization alone did not win out from the animal stage. Organization could, and does, exist without language and without man, but we departed from the animal through language and progressed through language. Language was produced by and for the story-teller. For his purpose was language developed, and without language we would have had no modern man. The neolithic scriber on bone, that "mamothistic etcher at Grenelle," was a later development of the story-teller, who told stories in pictures, and was not only the forerunner of the comic supplement, but of all that we understand in modern pictorial art. Later, he told stories in song and in mimicry, so that all our art, which represents our greatest departure from the anthropoid ape, is the work of the story-teller. He has been in the vanguard of all progress since we left the trees.

It is impossible to conceive of a geologist being eminent without this story-telling function being well developed. Unlike most story-tellers, he generally tells his own story of his own work. He is his own publicity agent; and what magnificent stories he has been able to unfold. In the second chapter of Genesis, and the second verse, we are told that God rested on the seventh day, and for a thousand years man had interrupted all his work every seventh day to signify his assent to the six-day history of the world's creation. The story-telling geologist comes along and says: "There is a mistake somewhere; it took several million years to create this earth, and I can prove it. Here are the proofs." When the world had become accustomed to the shock of this, the geologist's story went on to tell that man was not created on the sixth day, but that his creation was a gradual development occupying a period also of millions of years, the records of which in an almost unbroken chain stretching from the protozoa to modern man are preserved in the everlasting rocks. True, some links were absent, but every now and then the story is added to and the Neanderthal skull and our friend from Java help to fill in the blanks. Who couldn't attract attention and hold the stage with such stories as these? And the geologist had many such in his bag. He shows us where the moon was born. He dissects the teeth of the mammoth who wandered in our back yard before the ice was two miles thick upon it, and he counts the nervatures of the wing of the fly that plagued it.

But even the geologist's supply of stories could not keep up forever to these high-grade samples, and, as the family of geologists grew, they had to be content with less and less interesting stories. But stories they must have to maintain their eminence, and a story, to be a story, entails of necessity a hearer, a willing and an interested listener. As the quality of his stories waned he often had to expend as much pains finding the listeners as in finding the story, and this led him to the study of the listener, to the study of man, his characteristics, his wants, his needs, his foibles, and his weaknesses. He had to make the most of meagre stories, he had to study that phase of man which brought him listeners. This has been going on for generations, and the methods of the family of geologists in finding hearers is as well organized to-day as their study of geology. Are not many of them geologists in the summer and writers of their stories in the winter?

Now the story-teller is still the greatest man among us. What does Kipling get per word? and has he not had the refusal of the high honors of the realm? Theodore Roosevelt received $350,000 for seven years' work as President of the United States, but received a million dollars for the story of his African holiday. But the geologists' stock of interesting stories is running low, or rather the proportion of interesting stories to the number of geologists is becoming small, and instead of a greedily paying public he must perforce fall back on government bluebooks for publication.

And how do I interpret all this? I interpret it thuswise. The work of the geologist is in two parts. There is the study of geology to get the story and of man to get a listener. The engineer is so busy with his own work that he fails to study man. The geologist, with his knowledge of man and with his knowledge of publicity becomes useful to man in other ways.

The search for a listener has made the geologist in many ways a broader and a bigger man, and his art of story-telling brings him into the public eye.

Do I begrudge the honors to the geologist who has reached to high position through his knowledge of man? By no manner of means. I respect him, in some cases I bow down to him, but let us be honest about it and recognize that it is not the geology, but the story-telling and the man that has won to high honor.

Why, then, my half-brick of last year? It was not directed at the geologist as a geologist or as a story-teller but at men who were inclined to tell stories of no consequence to listeners provided by the reputation of the whole family of geologists, and to make capital out of these stories of no consequence. The geologist has from time immemorial been on a pedestal, and has, no doubt, taken care to be kept there. Round and about him, due to his art of story-telling, there has been a halo or an aura. His stories have not only had the important essentials of mystery and distance, but, in the main, they have been truthful and unquestioned by the general public. But there are those who would impose on this good name and on this long-earned and carefully preserved reputation.

I must confess that it is a source of some content to see the radical change that has taken place in our programme since last year, with the greatly reduced percentage of geological papers. There are many geological stories that we require, but that fact need not be abused.

This summer the geologists from all the world are coming here, and they will bring with them their best stories, and we, aided by government grants, have been diligently preparing for them, not only to hear their stories, but to provide them with new stories.

Their stories will be listened to by all manner of people, but by no one will they be more appreciated than by the mining engineer, for he will know and will preserve what he needs, and this he will use in practical work for the benefit of the community, and, going his own way, he will hold his peace and be unrecognized, and to the geologist and to the story-teller will be the glory.

The Grand Trunk Railway Company reports that during February it received on outstanding orders 428 box cars from the Pressed Steel Car Company, twenty-five box cars from the Canadian Car and Foundry Company; twenty-four Pacific type locomotives from the Montreal Locomotive Works; nine switch engines from the Canadian Locomotive Company; seventeen Mikado locomotives from the American Locomotive Company, and four refrigerator cars from the Canadian Car and Foundry Company.

RAILWAYS REQUIRED THIRTEEN MILLION TIES

There were 13,683,700 cross-ties purchased in Canada in one year. This in an increase of 4,469,808, or 48.5 per cent. over previous years. The increase is due largely to railway construction, which was specially noticeable in the Western provinces on the new transcontinental lines. The replacement of ties on existing lines amounted to about 10,000,000.

There were in all eighteen kinds of wood reported for cross-ties in 1911. Red pine, Western cedar, birch, maple, beech, poplar, Southern pine, elm and black ash were reported and classified separately for the first time.

Jack pine replaced cedar at the head of the list and formed about 40 per cent. of the total. The quality of available jack pine and its wide distribution were probably responsible for its popularity. Tamarack moved up from fifth to second place and formed over 19 per cent. of the total.

Douglas fir increased from 9 per cent. in 1910 to 14 per cent. in 1911 and moved up from fourth to third on the list. Hemlock fell back and formed only 12 per cent. The new railway lines are building north of the northern range of this species. Spruce increased from 2.5 to 6.6 per cent. on account of the same activity of railway building in the northern regions of the country.

Cedar took an abrupt fall from first place on the list in 1910 to sixth in 1911. Practically all the cedar reported is Eastern cedar, as the Western species is too soft for satisfactory use for cross-ties. The supply of Eastern cedar of either tie or pole size is practically exhausted. These six species together form 97 per cent. of the total. The others in the list are used in small quantities only, and for particular uses.

The average price of ties in 1911 was 39 cents, one cent more than in 1910. Of the species used in quantity, oak ties at 81 cents were the most expensive, and spruce ties were the cheapest at 26 cents. Spruce, hemlock and cedar all show a decrease in average price while jack pine, tamarack, Douglas fir and oak all show an increase. The prices of other woods are not comparable as they are purchased in such small quantities.

About 63 per cent. of the ties purchased in 1911 were hewn. In 1910 about 70 per cent. were hewn, so the sawn tie is evidently increasing in favor, states a recent bulletin of the forestry branch compiled by Mr. R. G. Lewis, B.Sc.F. Douglas fir ties were 94 per cent. manufactured in this way. Oak chestnut and Southern pine ties were more than 50 per cent. sawn.

Jack pine, tamarack, hemlock and spruce were mostly hewn, while cedar ties were about half and half. All the poplar and red pine ties were hewn.

Sawn ties cost on the average 41 cents, or 4 cents more than hewn ties, while in 1910 the hewn ties were the more expensive by three cents.

The ties purchased by electric roads were 81 per cent. sawn as opposed to 35 per cent. in the case of steam railways.

In 1910 the electric roads used only 38.6 per cent. of their ties sawn and 61.4 hewn, so with these companies as well as with the steam railways the sawn tie increased in popularity.

Of the sawn ties Southern pine ties were the most expensive at $1.11, with oak next at 82 cents. The cheapest sawn ties were of birch, beech and maple at 23 cents. Of the hewn ties chestnut were the most expensive at 58 cents and birch, maple and beech the cheapest at 20 cents.

Steam railways in 1911 used 95 per cent. of all the ties purchased. They purchased, in 1911, 13,094,528 ties—an increase of 4,185,106, or 47 per cent. over 1910. This increase is due, as stated above, to the construction of the new transcontinental railways. They used all the ties made from Western tamarack, Larix occidentalis, Western cedar, Thuja plicata, birch, maple, beech, poplar, Southern pine, elm and black ash.

Electric railways used only 5 per cent. of the total number of ties purchased in 1911.

The electric railways' total of 589,242 is an increase of 95 per cent. over 1910. This increase is greatest with Douglas fir, the use of which has increased over sixfold. Douglas fir was not used for ties by any of the electric railways of Eastern Canada. Fir ties formed over half of the total number purchased; this species replaced cedar at the head of the list. The cost of 20 cents is below the average for all kinds of wood.

Cedar ties, which had hitherto headed the list, fell back to second place with 28 per cent., and these ties increased in price from 37 to 41 cents, a price above the general average, demonstrating the increasing scarcity of this material.

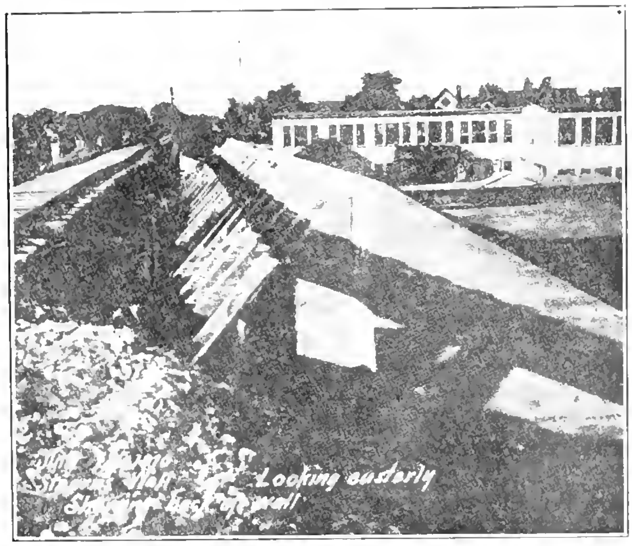
Tamarack shows an increase in number but a reduction in price. Tamarack is found in small isolated stands and its prices and quantities vary with the accessibility of the material to the railway line.

The average price of 29 cents per tie in all species used by electric railways is a reduction of 12 cents from 1910 and is due to the great reduction in the cost of Douglas fir ties, which form over half of the total. Electric railways got their ties 10 cents cheaper than steam railways. No red or white pine ties were used by electric railways in 1911.

REINFORCED CONCRETE RETAINING WALL.

An interesting article on a particular type of retaining wall appears in the last issue of The Cornell Civil Engineer. The author is engineer of grade elimination on the N.Y.C. & St. L. Railroad, and quoting from Mr. Himes' article on this subject he states:—

A wall of somewhat unusual design was constructed on the Nickel Plate in East Cleveland, in 1910. The purpose of



View Looking Eastward, Showing Back of Wall.

the wall was to permit the elevation of the N.Y.C. & St. L. tracks without encroaching upon the adjacent property. The owners of that property exhibited a very unfriendly spirit towards the railroad company, and it was deemed necessary to effect the elevation of the tracks without in any way encroaching upon the property.

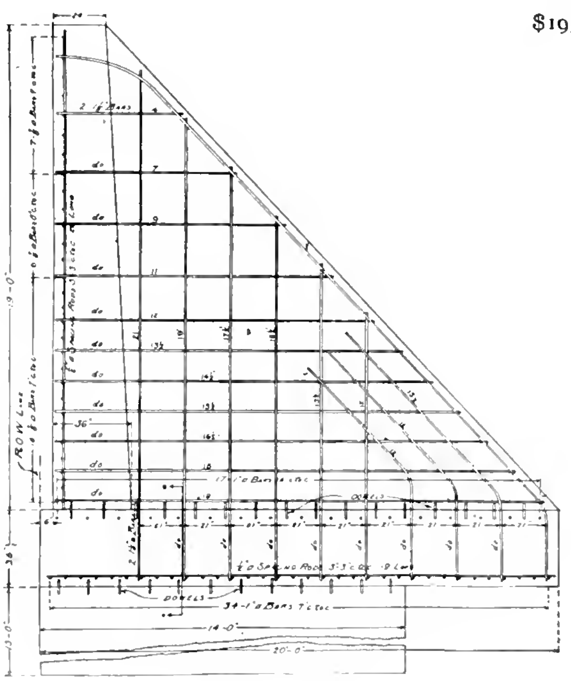
This made it necessary to carry the wall down to the rock surface, some 18 feet below the top of the ground. The centre line of the nearest railroad track was about 11 feet 6 inches from the face of the wall. The length of the wall was about 250 feet. A careful study of the problem was made and estimates prepared to show the comparative cost of a reinforced and a gravity wall.

The accompanying plans and the following tables show a full theoretical discussion of the subject and the final design, the formulæ of the American Railway Maintenance of Way Association being used.

Reinforced Counterfort Wall.

Loads per foot section.		C. of G. refer. to C tracks.	Moment.
Counterfort and main wall	30,320	5.4	183,700
Footing	9,000	2.5	22,500
Surcharge	9,600	0.0	00,000
Earth	20,790	—1.9	—39,500
Pier	30,000	5.5	165,000
Loads per foot of pier brought from intervening wall:—			
Main wall × 8/5...	6,400	11.0	70,400
Earth × 8/5.......	65,100	1.3	84,600
Footing × 8/5.....	14,400	5.5	79,200
Surcharge × 8/5 ..	15,400	0.0	00,000
	201,010		565,900

Item.	Quantity.	Unit price.	Cost.
Concrete (wall)	1,250 cu. yds.	$6.50	$ 8,125
Concrete (piers)	700 cu yds.	6.50	4,550
Excavation (wall)	40 cu. yds.	0.35	14
Excavation (piers)	1,125 cu. yds.	1.00	1,125
Steel	121,900 lbs.	0.025	3,050
Engineering & contingencies, 15%			2,530
			$19,394



Section C-D.

$X = 2.81$.

E = Thrust at pier;

E′ = Thrust brought to pier by intervening wall;

$E = .285 \times 36.5\ (36.5 + 20)\ 120 \div 2 = 35{,}280$ lbs.

$E' = .285 \times 22.25\ (22.25 + 20)\ 120 \times 8/5 \div 2 = 25{,}730$ lbs. per ft. of pier;

E acts at a height of $[(36.5)^2 + 3 \times 36.5 \times 10] \div [3 \times (36.5 + 20)] = 14'.26$

E′ acts at a height of $[(22.25)^2 + 3 \times 22.25 \times 10] \div [3 \times (22.25 + 20)] = 8'.84$

Taking bottom of footing at reference line,

Total horizontal thrust acts at a height of $(35{,}280 \times .01 + 25{,}730 \times 8.84) \div 61{,}010 = 3'.75$

Resultant cuts the base 4′.2 from front of footing.

Toe pressure $= 2 \times 201{,}000 \div (3 \times 4.2) = 31{,}900$ lbs./sq. ft. = 222 lbs./sq. in.

Resultant of forces acting on wall proper cuts the top of the pier 8′.0 from the face.

Toe pressure $= (4 \times 14 - 6 \times 8)\ 171{,}010 \div (14)^2 = 6{,}980$ lbs./sq. ft. = 49 lbs./sq. in.

Heel pressure $= (6 \times 8 - 2 \times 14)\ 171{,}010 \div (14)^2 = 17{,}450$ lbs./sq. ft. = 121 lbs./sq. in.

E′ = 16,080 lbs. per foot of wall at bottom of footing.

Solid Wall.

Loads per foot section.		C. of G. refer. to C tracks.	Moment.
Main wall × 20/8........	63,250	6.7	423,800
Footing × 20/8........	18,500	4.25	78,600
Earth × 20/8........	41,750	0.7	29,200
Surcharge × 20/8........	24,000	0.0	00,000
Additional load on pier—			
Pier	39,000	3.3	128,700
Earth	12,400	—5.9	—73,100
	198,900		587,200

Item	Quantity.	Unit price.	Cost.
Concrete (wall)	2,000 cu. yds.	$6.50	$13,000
Concrete (piers)	1,000 cu. yds.	6.50	6,500
Excavation (walls)	40 cu. yds.	0.35	14
Excavation (piers)	2,020 cu. yds.	1.00	2,020
Engineering & contingencies, 15%			3,230
			$24,764

E = Same as for counterfort wall = 35,280 lbs.

$E' = 285\ (22.25 \times 42.25) \times \frac{1}{2} \times 120 \times 12/8 = 24{,}120$ lbs.

Total horizontal thrust acts at a height of $[(35{,}280 \times .01) + (24{,}120 \times 8.84)] \div 59{,}400 = 3'.59$

Resultant cuts the base 4′.3 from front of footing.

Toe pressure $= 2 \times 198{,}900 \div (3 \times 4.3) = 30{,}837$ lbs./sq. ft. = 214 lbs./sq. in.

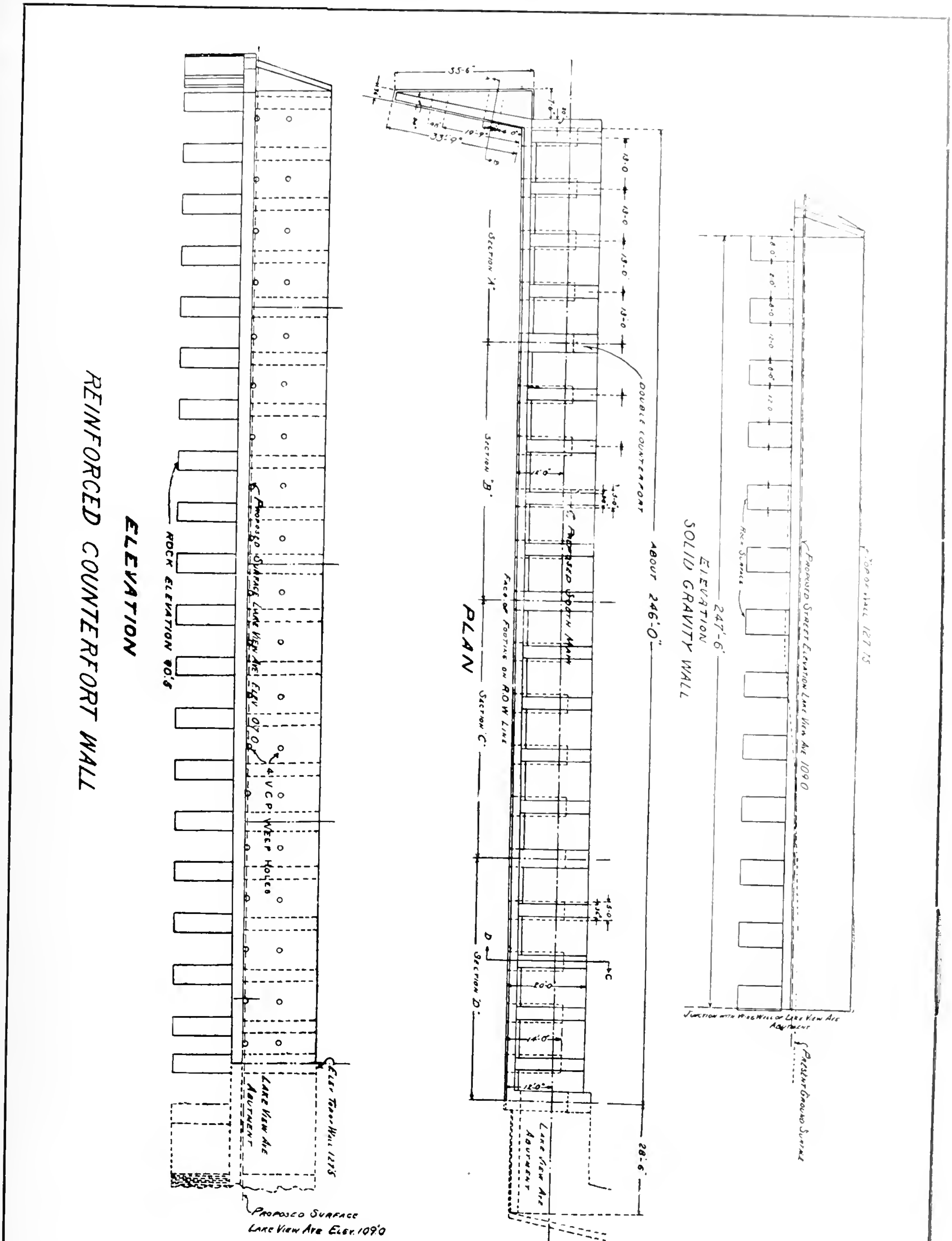
Resultant of forces acting on wall proper cuts the top of the pier 6′.5 from the face.

Toe pressure $(4 \times 16.5 - 6 \times 6.5)\ 147{,}500 \div (16.5)^2 = 14{,}628$ lbs./sq. ft. = 102 lbs./sq. in.

Heel pressure $(6 \times 6.5 - 2 \times 16.5)\ 147{,}500 \div (16.5)^2 = 3{,}250$ lbs./sq. ft. = 23 lbs./sq. in.

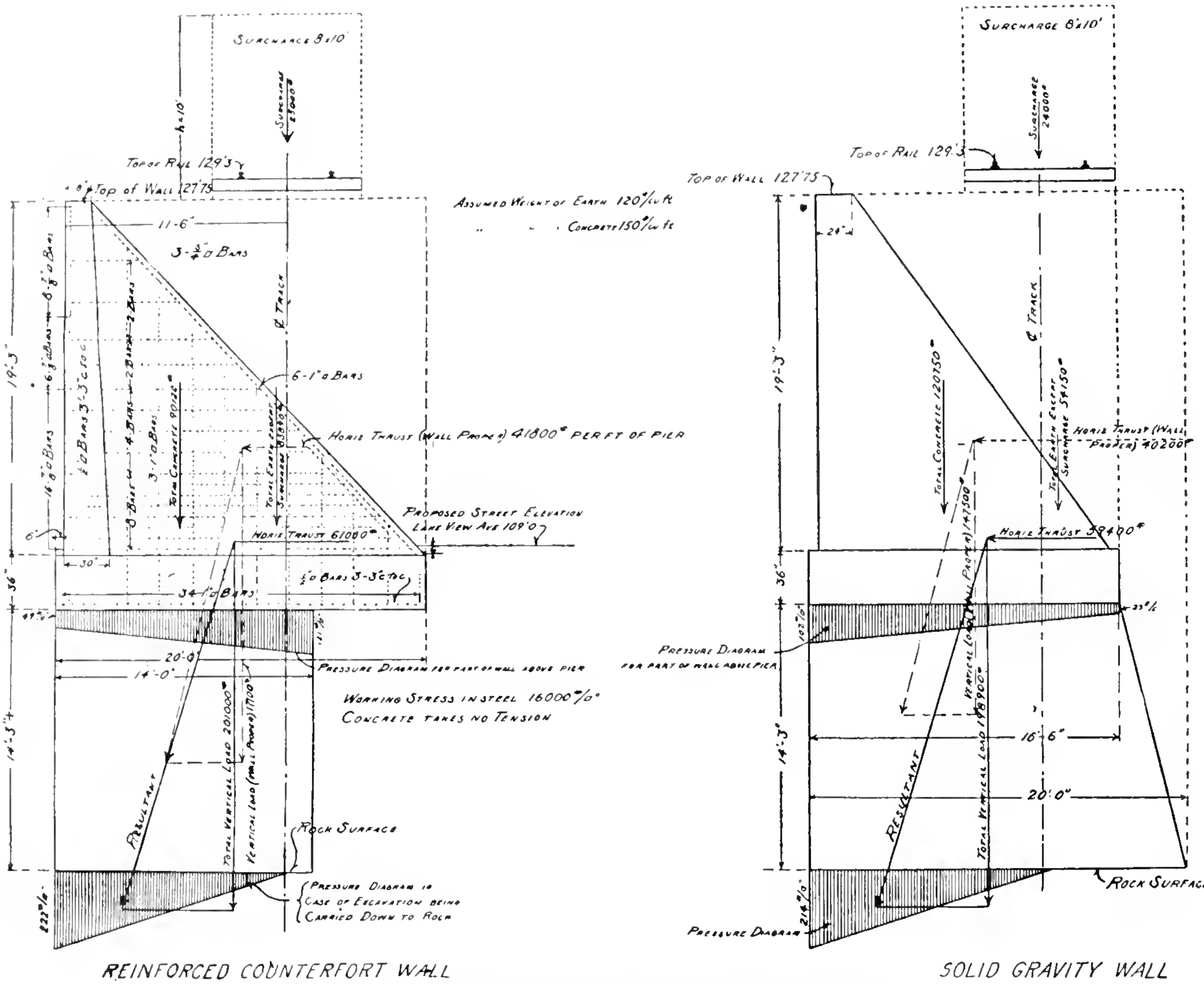
The estimated cost of the wall as finally designed was $23,570, and the actual cost after writing up the accounts was found to be $21,342.20. The estimated saving over the cost of a gravity wall was about 20%. The wall was constructed with the forces of the Grade Elimination Department, not by contract.

A feature of special interest in the wall is the manner in which the load was distributed, so as to prevent the maximum pressure from occurring at the toe of the wall on the top of the pier. Theoretically the maximum toe pressure occurs in the face of the wall at the rock surface, but since the ground surface is near the top of the piers, it is probable that the maximum toe pressure at the rock surface is somewhat less than calculated. The face of the piers was built exactly on the property line. The face of the wall was set back 6 inches, in order to insure that no part of it would by mischance en-


ELEVATION
REINFORCED COUNTERFORT WALL
PLAN
ABOUT 246'-0"
DOUBLE COUNTERFORT
ELEVATION
SOLID GRAVITY WALL
247'-6"
4" V.C.P. WEEP HOLES
LAKE VIEW AVE ABUTMENT

croach on private property. The wall has now been two years in service and no change of any kind has yet occurred.

The accompanying pictures illustrate the methods employed in its construction. At the street, abutments were constructed for the bridge over the highway. These abutments have no physical connection with the wall, being stalled and the joint so arranged that should either wall be inclined to tilt forward it would receive support from the other. Two-inch stone was used in the construction of the wall. It was found that because of the closeness of the reinforcing bars it was difficult to get the coarse concrete material in place. The use of smaller stone or gravel would



NOTE.—It is a condition of the design of wall that it shall be so constructed as to be perfectly stable in the event of the removal of all material above rock surface immediately in front of wall.

Comparative Designs and Estimates for Proposed Retaining Wall.

separated with carefully constructed joints. The several sections of the wall, A, B, C, D, were likewise separated by expansion joints. All of these joints have opened a trifle during the winters. A joint at the juncture of the main wall and the wing wall was located so as to bisect the angle between the walls. This location is always a plane of weakness and subject to cracks. In this case the crack was fore- have secured somewhat better results and cost less money. Quicksand was encountered in the foundations, but occasioned no serious difficulty beyond the settlement of the temporary trestle, from which the material was handled.

The details of the wall and the calculations were worked out by Mr. A. C. Irwin, formerly Professor H. S. Jacoby's assistant.

BRITISH LOCOMOTIVE CONSTRUCTION.

A mammoth new locomotive, 63 ft. 4¾ in. in length, weighing 116 tons, has been constructed by the London and North-Western Railway Company, and named "Sir Gilbert Claughton," in compliment to the chairman of the company. Having given full satisfaction on its trial, the new engine is regarded as the first of a practically new type of London and North-Western locomotives. It is a four-cylinder engine, the boiler is 5 ft. 2 in. in diameter and 14 ft. 6 in. long, and the three great coupled wheels on either side have a diameter of 6 ft. 9 in.

The construction of the new engine is a sequel to the interesting exchange of locomotives for trial purposes which was carried out between the North-Western and the Great Western two years ago. The experiments were continued for a week, and the North-Western Company came to the conclusion that the four-cylinder engine used by the Great Western was suitable to the requirements of the North-Western road. One of the first official duties of the engine will be to take the King on a visit to the London and North-Western works.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, APRIL 3, 1913. No. 14.

CONTENTS OF THIS ISSUE.

WESTERN LIGNITE POSSIBILITIES.

Word comes from Manitoba that the experimental station of the Provincial Government at Estevan for investigating the commercial possibilities of lignite coal is now under construction. Professor Darling will be in charge of the station, and it is expected to prove as tests progress that the deposits of lignite coal of the Souris valley have potential values for power purposes important to the whole of the southern portion of the Province.

It is sincerely to be hoped that this experiment of the governments will prove all that they could wish for in the way of fuel possibilities. Water powers are neither so frequently available nor powerful when found in the comparatively level prairie provinces as in other parts of the Dominion. Any absence of a plentiful and cheap fuel supply will make industrial advancement still more difficult.

Events seem to be steadily pointing to the practical utilization in the middle west of lignite on a large scale. For several years past the United States Government has been carrying on tests of the fuel possibilities of Dakota lignites, etc., and tests showed that while the best coal produced .28 horse-power per hour under boiler, lignite when operated as a producer gas produced .30 horse-power per hour. It is difficult to make use of lignite profitably in its raw state, as the moisture amounts to about 40 per cent., and it slakes and disentegrates into small particles if allowed to weather for more than a few months. Briquetting has been tried successfully as an improvement on the raw lignite, and, while it about doubles the cost, the heating value is increased 50 per cent. and the moisture reduced to 20 per cent.

It is well known that the railways operating in that part of the middle west of the United States where coal is expensive and beds of lignite close at hand have been particularly active in investigating the commercial practicability of lignite for their use, and have apparently come to affirmative conclusions. With the aid of specially designed spark-arresters the Chicago and Northwestern in part use lignite, and the Oregon and Washington Railroad and Navigation Company have specially designed locomotives of the Mikado type using it as a fuel.

It is to be hoped from tests that the future serviceability of the deposits in the Canadian West prove encouraging and give an added stimulus to the progress of that great region.

ROAD DESIGN.

In all parts of the Dominion is heard the slogan of good roads. Counties are adopting modern methods of highway construction, and cities and towns are vieing with each other in their plans and preparations to out-do rivals by abolishing unsightly streets. Governments, both provincial and federal, are making appropriations of large sums for road construction, and everywhere there is unprecedented activity towards better highways.

It is a time to be wary. The basic principle of good road construction has not changed since the days of Macadam and Telfor, but, thanks to modern traffic requirements, there has been the evolving and trial of numerous types of road surface. Many of these have well-known advantages for particular kinds of traffic, but variety has brought us up against a varying design of road surfaces that only an accurate knowledge of traffic requirements can enable one to pass judgment upon satisfactorily.

Canadian engineers should go carefully in their design and specifications for road surface. There are

large expenditures involved, and it will be cause for great regret if in the enthusiasm and haste to build good roads economical design is faulty due to a lack of proper information on traffic requirements. In the design of country roads especially, the engineer is likely to encounter difficulties, and should have an accurate traffic census for reference. Fast automobile travel, heavy truck traffic (both horse and machine), the use of narrow and wide tires, all increase the problems, and have to be considered and fullest information obtained on same, if one is going to do himself justice. Almost of no less importance must be the ability to foresee the traffic that will take place after his design has been carried into effect.

Prof. Blanchard, of Columbia, makes a definite classification of the most essential information concerning traffic; to be used in judging the suitability of a constructed road for the traffic upon it; considered as a basis for future designs, and in deciding the character of design to be adopted for a new road surface. In the latter case estimates of future changes to be made.

"(1) Differentiation between horse-drawn vehicle traffic and motor car traffic.

"(2) Division of each of these classes of traffic into pleasure and commercial traffic.

"(3) Subdivision of commercial traffic into loaded and unloaded vehicles.

"(4) Determination of the weight per linear inch of width of tire of all types of commercial traffic.

"(5) Subdivision of the two classes of horse-drawn vehicle traffic, dependent upon the number of horses.

"(6) Subdivision of pleasure motor car traffic upon the basis of weight and speed, since, in many instances, the greatest damage to certain types of roads is caused by seven-seat touring cars, limousines or landaulets, travelling at speeds of 40 to 60 miles an hour.

"(7) Extraordinary character of local traffic; for example, traction engines hauling trailers, motor bus traffic, ice wagons, milk drays, etc.'

These points are further brought out by observation, as, for instance, the sharp calkes on horses' feet in winter often rapidly deteriorate what under other circumstances would be a perfectly serviceable road. They bear out the well-known truth that the amount and character of traffic are of the utmost importance to the life of the road. Accurate traffic data should be taken, both for the construction design and after building for purposes of reference and repair. It does not appear to be as thoroughly carried out as the importance warrants, and it is to be hoped the coming summer will see much useful data collected not only for present benefit but future usefulness.

SPRING FLOODS.

The past week has witnessed the occurrence of the most disastrous floods in the history of the United States. A combination of heavy spring rains and previously swollen rivers was the cause, and there is a regrettably long list of dead as the result. Ohio and Indiana have been the chief sufferers, and Dayton City, of the former State, a city of considerable manufacturing importance, was cut off from communication for days, and in great part entirely submerged by the Miami River. Events are too fresh in the reader's mind and were too fully published in the daily press to need description here, suffice that several tributary streams meet in the Miami River just above the city, and the confluence of their swollen waters, together with a broken dam, appear to have been the cause of the destruction. Throughout the above mentioned States record flood levels have been attained by many of the streams, and the destruction wrought and the number drowned is astonishing.

Such a catastrophe is horrible to consider, and, we believe, unnecessary of occurrence. Every spring we see damaging floods in the United States to the extent of millions of dollars worth of property. Some of that money spent in preventive measures would go a considerably long way towards controlling the floods, and should certainly be used to prevent an outrageous loss of life, such as in the present occurrence. Given the opportunity and money, and engineering ability can collect data and devise means to greatly control floods. If it is beyond finance and practicability to control them, engineers can at least point out the danger zones, and people should be forbidden to reside within them.

The deforesting that has taken place in the flood area is, without doubt, in a great measure responsible for the exceptional flood conditions, and makes it very plain that the United States Government will have to do something to offset the lessening of nature's storage reservoirs.

Canadian flood problems are small in comparison with our neighbors to the south, and, thanks to provision of nature, are likely to remain so. The Great Lakes, acting as storage reservoirs, rapidly drain and make any disastrous floods in the settled portions of Ontario impossible. Further back in the Laurentian Hills, even if deforested, numerous lakes would make storage provisions, with the help of dams, comparatively easy. The prairie provinces having been always comparatively bare of forests are not likely to incur any great increase of the flood heights to which they are accustomed.

Our general topography and lake systems leave us without such gigantic flood problems to struggle with as has the United States in the Mississippi Valley and its tributaries. Nevertheless, there are valuable lessons to be learned from a study of the recent catastrophe in Dayton, and, no doubt, our government will avail itself of the opportunity.

TELEPHONIC TRAIN CONTROL IN ENGLAND.

The first train-controlled system by means of the telephone in England has just been installed on one of the railways in Wales. The following description of the system recently appeared in a London journal:—

As the result of the installation of a system of telephones in all signal cabins, junctions, and stations on the line, the whole of the train working can be completely and directly controlled from the head office at Cardiff. The train controller in the general office can, by means of the telephone at the different points, know precisely the movements of all the trains, and is able to divert a train almost at a moment's notice.

It is believed that as a result of the new installation much time will be saved, and consequently that there will be quicker dispatch. It is anticipated that the new service will prove not only useful to the railway company, but also to the large number of collieries which are on the railway system and whose output forms such a large proportion of the traffic. By the telephone system as many as 45 stations may be connected to one pair of trunk wires, any one station of which may be rung up by the train controller without ringing the bell at any other station, and the controller can hear the bell ringing at the station called. On the other hand, if necessary, all of the stations on the system may be rung up at the same moment.

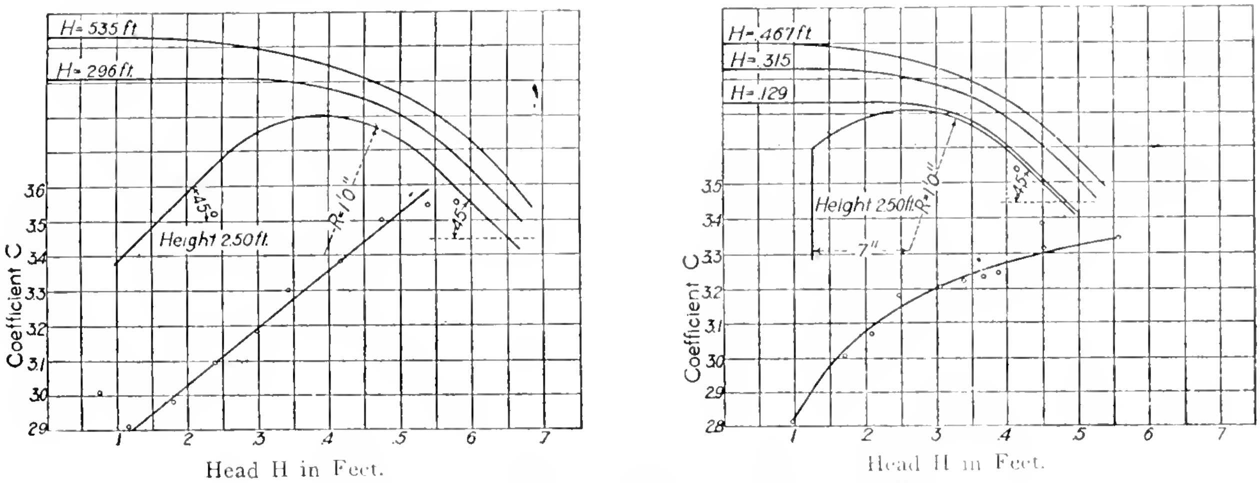
EXPERIMENTS ON FLOW OF WATER OVER MODEL DAMS.

A series of experiments to determine the flow of water, under low heads, over four models of dams was undertaken at the hydraulic laboratory of Purdue University as the graduation thesis of Messrs. Lane and Kemmerer. The investigation was carried out under the general direction of Prof. R. L. Sackett, who reported the results in a paper presented before the Indiana Engineering Society on Jan. 25.

The model dams were placed in a concrete channel 100 ft. long, 3 ft. wide, by 35 ft. deep. The length of crest was in each case the width of the channel. Discharges were measured with a Venturi meter; and the elevation of water surface was determined by a hook gauge.

The results obtained by Bazin, the U.S. Geological Survey, as given in Bulletin 200, and by Rafter and Williams in 1899 were compared and models selected which would add to the variety of sections and heads heretofore experimented with.

The first model was a flat crested weir 0.98 ft. wide and 2.38 ft. high. This is about the width of No. 47 of the U.S. Geological Survey experiments and between models No. 2 and No. 113 of Bazin's work. Results were plotted for Bazin's dam, 1,315 ft. wide, the U.S. Geological Survey dam, 0.927 ft. wide and the Purdue model No. 1 with a crest of 0.98 ft. wide. The form of the surface curve also was plotted from data taken on the checker-boarded vertical side-walls of the channel.

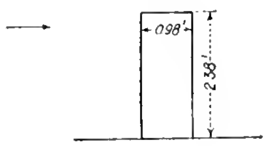
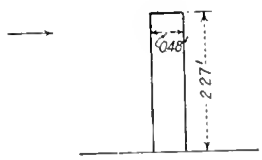
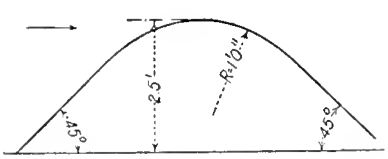
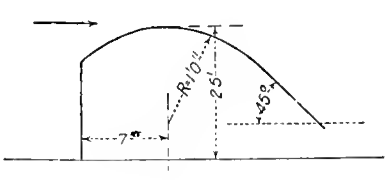


Surface Curves and Coefficients, Models 3 and 4.

The second model was the same as the U.S. Geological Survey No. 40, except that the height was 11.25 ft. in the latter and 2.27 ft. in the Purdue model. The results in both cases were plotted, and it is believed by Prof. Sackett that at low heads the data are of some value. The surface curves were plotted for three heads.

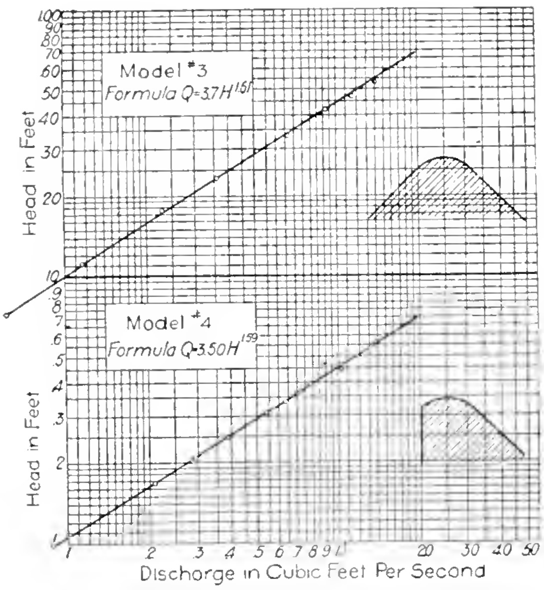
The effect of the partial vacuum formed below models 1 and 2 was very noticeable on the surface curve, but com-

Observed Flow Over Model Dams

Model	Discharge per ft. of crest cu. ft. per sec.	Head	Coefficient C in $Q = CLH^{3/2}$	Exponential Formula	Per cent Difference
	.263	.211	2.71		−1.5
	.359	.264	2.64		+0.8
	.503	.331	2.64		+1.0
	.635	.385	2.66		+0.5
	.761	.435	2.65	$Q = 2.67\,LH^{1.60}$	+0.7
	.787	.447	2.63		+1.4
	.937	.497	2.68		−0.1
	1.090	.548	2.69		−0.6
	.250	.212	2.56		−3.0
	.347	.261	2.60		−0.6
	.463	.313	2.65		+1.7
	.613	.367	2.76		+0.8
	.604	.368	2.71	$Q = 3.42\,LH^{1.71}$	+2.6
	.780	.424	2.82		+1.4
	.933	.462	2.97		−2.0
	1.130	.518	3.03		−1.6
	1.330	.568	3.10		−2.3
	.0605	.074	3.01		−1.4
	.112	.114	2.91		−1.8
	.223	.177	2.98		+0.9
	.359	.238	3.09		+1.5
	.516	.297	3.18	$Q = 3.81\,LH^{1.63}$	+1.7
	.656	.341	3.30		+0.2
	.903	.415	3.38		+0.2
	1.140	.474	3.50		−1.8
	1.400	.539	3.54		−0.7
	.0839	.096	2.82		+0.7
	.207	.168	3.01		0.0
	.293	.209	3.07		0.0
	.388	.246	3.18		−2.1
	.538	.305	3.20		−0.3
	.634	.339	3.22	$Q = 3.58\,LH^{1.60}$	+0.2
	.711	.364	3.23		+0.1
	.785	.388	3.24		+0.4
	1.016	.448	3.38		−2.3
	1.007	.452	3.31		−0.1
	1.390	.557	3.34		+1.4

parative data with and without the vacuum were not taken. The results are with the nappe aerated—a fact which it is necessary to consider when comparisons are made.

Model 3 is similar in section to the hollow, buttressed type of concrete dam and model 4 is the same, with the sloping approach omitted. Model 4 is a small scale reproduction of the Yakima dam, and the surface over which the water rubbed was formed of cement mortar and closely resembled the troweled finish of concrete. It is similar in form to type L, page 73, of Williams and Hazen's Hydraulic Tables.



Discharge Curves, Models 3 and 4.

The coefficients for models 3 and 4 are nearly the same for heads of 0.1 and 0.3 ft., indicating that for such low heads the upstream slope has little effect on the coefficient. As the head increases the curve is a straight line for model 3, and curved for model 4, showing the effect of the sharp corner within the limits of the heads used.

The curves show the observed head on the crest and the coefficient C in the formula, $Q = CLH^{3/2}$.

The table shows also the constants C_1 and n in the formula $Q = C_1LH^n$, where H is the observed head plus the velocity head.

CONCRETE AND STEEL.

Building regulations of Greater New York require that in reinforced concrete the stresses in the concrete and steel shall not exceed the following limits:—

	Per sq. in.
Extreme fibre stress on concrete in compression ..	650 lbs.
Concrete in direct compression	500 lbs.
Shearing stress in concrete when all diagonal tension is resisted by steel	150 lbs.
Shearing stress in concrete when diagonal tension is not resisted by steel	40 lbs.
Bond stress between concrete and reinforcing bars	80 lbs.
Tensile stress in steel reinforcement............	16,000 lbs.
Tensile stress in cold drawn steel wire used as column hooping	20,000 lbs.

In continuous beams the extreme fibre stress on concrete in compression may be increased 15 per cent. adjacent to supports.

EXPLOSIVES.

By J. K. Moore.*

In nearly all kinds of construction work carried on by engineers, blasting and the use of explosives play a more or less important part. With the arrival of spring and the start of active construction, it would not be out of place to discuss different types of explosives, their most efficient use and details of the proper handling of same. Nearly all accidents occurring from explosives are through negligence or from ignorance, foolhardiness or carelessness, and it behoves all workers with same to be thoroughly posted on the subject.

Some high explosives have a powerful action over a small area, being instantaneous in combustion. Others not so powerful, but shake up a large mass. One will smash rocks to pieces, rendering them useless for building purposes, but suitable for loading for a steam shovel. Others just the opposite, explosion being prolonged and the action more of a push than a direct blow, thus leaving the rock almost free from fracture and suitable for dimension stones, etc.

You therefore see that all have their uses and should be used in their right places in order to get the best results.

If the rock is hard and solid and not wanted for building purposes, use a high explosive; it will do the work. But if the rock is for building purposes, or even macadam, use a milder quality; you will have the better results and get your stones almost free from powder flaws. If the rock is soft or medium, you will find a high explosive is too local, so you must use the third or lower grade of dynamite, 40 per cent., or if the rock is for building purposes you must use a still milder quality, such as black powder.

Mistakes are often made in regard to producing rock for macadam. If the rock is hard and flinty a high explosive breaks it into pieces like spallings, full of flaws, and the additional fracturing, after having been broken by a stone breaking machine, renders it unfit for heavy traffic becaus it grinds down too quickly. But if a milder explosive i used, the fracturing is reduced to a minimum and the lif of the macadam prolonged, in some cases, about four times.

I have seen this experiment tried with the two explosives, put through the same stone napping machine at different points where the traffic was almost equal, rolled in by a steam roller, dressed with half-inch chippings and sand from the same rock and finally rolled with water and well brushed, so as to produce a good surface.

The one produced with the low or mild explosive lasted just three times the one produced by the high explosive or dynamite, and as one road surveyor put it, was almost like machine broken metal and hand broken metal in comparison.

Drilling.—To prepare rocks for the explosives, drilling has to be done. There are various ways by hand, steam, compressed air, etc.

There are several methods of hand drilling, the auger or rotary drill for soft rock and coal, the hammer or jumper drill and the churn drill. The last two are more suitable for our purpose, where drilling is light, and as a rule we keep out of rock as much as possible in laying out a road.

The hammer or jumper drill is familiar to us all and it is maintained by many that one man can drill a hole to a depth of three feet cheaper than three can do, by using the hammer in one hand and turning the drill with the other. When the hole is well entered, a splasher is used on the

*Road Superintendent, Cariboo and Lillooet Districts, B.C.

drill and water is poured in the hole. The water makes drilling easier, as it keeps the bit of the drill cool and moistens the drillings, which, when dry, cushion the blow, thereby reducing the striking force on the rock. When the drillings get pasty and stick to the drill, more water is used, and so on, until cleaning is required. Cleaning is done with a cleaner, which has a spoon button on one end and an eye on the other. The eye is used to dry out the hole by using cotton, hay or other material. Another way to clean the hole is by using a loose clack or single-hinged valve, circle pump. The clack, or hinged valve, is inside the pump on the bottom end, and as you put it down the drill hole, on coming in contact with the drillings, the valve raises and fills the pump, and as you raise it again, the valve closes and you empty it, and so on.

Up to ten or twelve feet the hammer drill does well, but after that it becomes slow, the drill being heavy to handle, etc., so that it would be better to use a churn from there up to about twenty feet.

Springing.—Having the holes drilled and ready for the charge, we must proceed. Every miner and powderman knows the benefit of having as much as possible of the charge at the bottom of the drill hole, also the advantage of springing the holes several times to make room for the charge at the bottom. The downward force of explosives is surprising and the result for those who practice springing deep holes, or chambering, is marvelous.

Springing of rock is to open up the joints at the bottom more than to make a pot hole so as to get the charge well down. I have seen holes sprung about four times in the following way:

A line of six holes were drilled about twenty feet deep, about ten feet back from the face of the quarry and about twelve feet apart. The rock was igneous, blue whinstone or granite, and about thirty feet deep, so that you will notice the holes were about two-thirds the depth of the rock. The width of the first drill was two and three-quarters and the last about two inches.

If, in drilling, the drill sticks in a joint, steel chips should be used to fill the joint. I have found this excellent in labor saving, as a troublesome hole is a nuisance.

The springing was done with black powder, glazed, because the rock was for making building stones, kerb stones and setts. The holes were sprung separately and about ten pounds used first time in each, with no tamping and fired by battery. This was more to find out how firm the joints were at the bottom. The second charge was about double that amount which opened the joints a little. This was continued until the joints were wide enough to receive the whole charge. One was a little large and was taking more powder than it should, so a little water or oil was used to make the connection good between the charge and the bore hole where the wire fuse was. This is a common custom amongst quarrymen in these building stone quarries where gunpowder is used, but should only be used if you cannot otherwise catch your powder with the fuses.

The total charge was about 350 pounds of gunpowder and the result was first class, nearly 3,000 tons being displaced. If this had been in ordinary excavation, 40 per cent. dynamite would have done to spring the holes, and 60 per cent. dynamite for the main charge.

Chambering.—I have also placed charges in chambers, but they were small, because the amount of work was light. However, there are several ways of running them, in the form of a "T" or a "Y," etc., the main tunnel being straight and the length in accordance with the work to be done. The branches are where the powder is stored. The main thing in loading these chambers is to exclude the air, build the explosive up as closely as you can, and after you have put in your primers (two at least should be used) and wires, the chambers should be built up solid with cement and stone or brick as explosives will follow up the line of least resistance in nearly every case—then fire as any other shot. The result is fine if everything is well judged, but in rock for macadam or building purposes, unless the mine is small and the output large, it is not so good for the stone, because rock, as you will know, does not work so well after it has been exposed for a time to the weather, as it gets dry and the natural moisture, or life, in the rock gets burned out and a man can not produce as many building stones, nor a machine as much macadam. And, again, if practised near a roadway it is liable to close the road to traffic for some time. Yet, for railroad contractors, mine-owners, etc., it is very satisfactory and cheap.

The difference in explosive properties are—dynamite is instantaneous and powerful over a small area; Judson powder is progressive and not so powerful as dynamite; Black powder is slow and progressive by combustion, but about half the power of Judson powder.

Dynamite and Judson powder can not be exploded the same as Black powder, by a spark, but requires force or shock, like a blow from a sledge, so a detonator or cap has to be used. The same method has to be used for exploding all nitro-glycerine compounds.

Care must be exercised in the selection of detonators or caps. The stronger the caps the better, and the more certain of entire explosion.

Testing Dynamite.—If dynamite is hard and resists yielding to the pressure of the fingers, it is frozen. It should not feel greasy, nor should there be a trace of nitro-glycerine on the wrapping paper.

In order to find out whether dynamite leaks or not, place it on clean paper and leave it in a room to dry in about 60 degrees Fahrenheit and leave it for about eighteen hours. If, on examination, there is any oily discoloration on the paper the dynamite has leaked. The best quality of dynamite should not do this. Fusing and thawing several times tends to leakiness, therefore it should be avoided. Again, on examination, if the dynamite has a whitish crust it is no longer safe, because the whiteness means dampness, and the nitrate of soda has leaked out. If it shows greenish spots, it shows that the nitro-glycerine has started to decay and it is therefore very unsafe.

Dynamite freezes more easily than water. It is the nitroglycerine that freezes at from 42 to 46 degrees Fahrenheit, according to the character of the material in it. When frozen it is hard and can not be loaded very easily into drill holes, nor is it very easily exploded. Yet it has been proved that dynamite can be exploded when frozen, but it takes greater detonation, and some engineers say it has been proven to be more powerful when complete explosion takes place, but it is not advisable to try it and any one doing so is running a great risk.

Thawing Dynamite.—Dynamite must be thawed. In doing so a large proportion of accidents from explosives happen.

The following is a list of what should not be done to ensure safety of powderman and men working with him. Many of the following being done through ignorance, and a list of the same should be copied out and distributed, one to each foreman, and the powderman failing to follow these rules should be instantly dismissed or given other work.

1. Never allow dynamite to be placed in front of a fire to thaw.

2. Never allow dynamite to be placed on a stove or heated metal.

3. Never allow dynamite to be placed on hot stones or gravel, or sand.

4. Never allow dynamite to be placed near glass of any kind in direct sun's rays.

5. Never allow dynamite to be placed in a tin and thawed over a candle.

6. Never allow dynamite to be placed on end round a lamp or candle.

7. Never allow dynamite to be dipped in hot water to thaw it.

8. Never allow dynamite to be carried in men's pockets or breasts to thaw it.

9. Never allow dynamite to be placed in a blacksmith's hearth in the ashes.

10. Never allow dynamite to be placed on a shovel and held over a fire.

11. Never allow dynamite to be placed around or on a boiler.

12. Never allow dynamite to be placed around or on an electric globe.

13. Never allow your men to slit dynamite open with a knife when frozen.

14. Never allow dynamite to be thawed in a can or metal pot surrounded by a water jacket if the water is in any way connected with fire, nor rubbing it in the hands to hasten thawing.

No. 7.—Thawing in water is an exceptionally dangerous form, because the water becomes highly explosive from leakage and has been known to cause serious accidents.

No. 14 has caused many fatal accidents through the dynamite becoming overheated and the nitro-glycerine dropping on the hot metal.

Nos. 1, 3, 5, 6 and 7 are very common ways used for thawing dynamite amongst powdermen in this country, and even if you have been lucky enough not to have had an accident therefrom, that does not reduce the danger any.

There is only one perfectly safe way to thaw dynamite, and that is to put in a warm room at summer heat, covered up and kept as dark as possible, away from the direct sun's rays and allowed to thaw out.

There are two other comparatively safe methods. One is in fresh horse manure in a box built for the purpose, and the other, in a can or metal pot surrounded by a water jacket. In this latter case remember warning No. 14.

The very best way is to never allow it to freeze, if you can do so by placing it in a frost-proof magazine.

Familiarity breeds contempt even for dynamite, by some, and as dynamite can be alight and burn up under certain conditions, adds in a degree, to the careless handling of it.

Primers and Loading.—Warning—In loading dynamite in drill holes, etc., never use anything but wooden or copper rammers, wood is preferable. Never allow anyone to help you who is smoking, and do not smoke yourself. Never let the sticks of dynamite drop heavily down a deep drill hole, nor force it into too small a hole or aperture, nor strike hard when ramming it into place. Caps are set off by a spark from the fuses and they explode the dynamite. Never allow caps to be lying around you while loading, nor carry them in your pocket, as you are apt to drop and explode one. Also, never allow nitro-glycerine to get on the hands, as it is easily absorbed and causes bad headaches.

The best method to loan a hole or place a charge, is, slit the cartridge on two sides, let the contents slip down gently, then take your rammer and press it gently to place. Then take a second cartridge and repeat the above, and so on, until you are ready for the primer.

In making primers, use the best quality of detonators, or caps, and first quality safety fuses. Take the cap and see that there is no sawdust left on it, then take the fuses, cut off the end and see that the powder is exposed and dry, then enter it in the cap and press it up to the fulminate. Be sure this is done because shots often miss-fire through the fuse failing to set off the cap. If the fuse is larger than the cap, scrape it down to fit, only do not open the cap, then press or clamp the upper end of the cap to the fuse, being careful not to disturb the fulminate in the cap. Never clamp the cap on to the fuse with your teeth or fingers, but use nippers or pincers, a tool made for the purpose, which cuts the fuse and clamps the cap to the fuse.

If you are working in wet ground or rock, use lots of grease or soft soap around the joint you have thus made and see that your fuse is waterproof. Double or tape gutta-percha fuse is the safest in water. After the cap and fuse are ready, take a cartridge of dynamite, open one end and make a little hole with a pointed stick, then insert the cap and fuse and gather the end of the cartridge paper around the fuse and tie with a piece of cotton. If in water, grease the joint well, as previously mentioned, then place with the charge, placing one or two more cartridges on top.

Then tamp with fine clay or sand, putting in a little at a time, and at first pressing lightly. Be careful not to check the fuse or draw it away from the charge, and do not use anything but a wooden or copper tamper or rammer.

Use lots of stemming or tamping, always be on the safe side in a final charge, then cut off the part of the coil of fuse not wanted and place it on one side. Be sure you have sufficient fuse to allow everyone to get away. Accidents often happen through neglecting this point, and, after all, one foot of fuse does not cost very much.

Signals for Firing.—After everything is ready, clear away all your remaining explosives and tools to a safe place, and on return, shout "fire" or give other warning. Then when you see that every one has laid his tools safely to one side, give a second warning and split the end of your fuse, and before lighting, see that every one has gone, then light the fuse, give a third and final warning, and take shelter yourself.

Never use water for drinking purposes coming from rock or ground you have recently used dynamite in as it will cause sickness and headache. If several shots have to be set off at one time, use wind-proof fuse matches or a spitter, and, if matches, never allow one man to set off more than two or three shots. If more than that he should have a helper to light them, and remember, a flame will not light a fuse, it must be a spark.

To make a spitter, or touch, take about twelve to fifteen inches of fuse, cut into the powder every one and a half to two inches, then light, provided everything is ready and the warnings sounded, and hold it to each fuse in the shots. It will readily light, but I would not advise more than four or five shots to each man. In the smallest of shots be careful of your fuse and see that you leave sufficient length to give you time to get away. I would not recommend less than twelve or fifteen inches even if the fuse has been tested as to time.

Black Powder.—In charging holes with black powder never use an iron rammer, always use wood or copper. Never allow fire of any kind near the charge, and if loose, always use a zinc or copper can, or flask to carry it in. Use a zinc or copper filler when charging the hole, and if the hole is horizontal, or has an upward tendency and hard to load, use a copper tube made for the purpose. If the angle is too heavy, you may have to make a cartridge containing the amount of explosive required, with a fuse inserted. Upright or vertical holes are rarely used in road work.

(To be continued).

THEORY AND PRACTICE OF STADIA SURVEYING.

By J. A. MacDonald.

The credit of having first introduced this method of surveying into America belongs to Mr. John R. Mayer, a French-Swiss. It was used by him as early as 1850; and subsequently during his connection with the United States Lake Survey, he did much towards perfecting the instrument and improving the methods of work. An essay by him in the Journal Franklin Institute for January, 1865, contains a short historical sketch of the development of topographical surveying and brief discussion of the general principles of stadia measurements.

The many advantages of stadia measurements in surveying need not be dwelt upon, both because attention has been repeatedly called to them, and because they are self-vident to every engineer, so far that all instrument-makers now take especial precaution in fitting the telescopes of all good transits with carefully adjusted stadia hairs This paper will therefore dwell on the theory and practice with a view of encouraging the use of this simple, rapid and wonderfully accurate method of surveying in a larger degree than has been. Tests of correctness of stadia readings with a transit having fixed stadia hairs not properly adjusted to the unit 100, has prompted the following article.

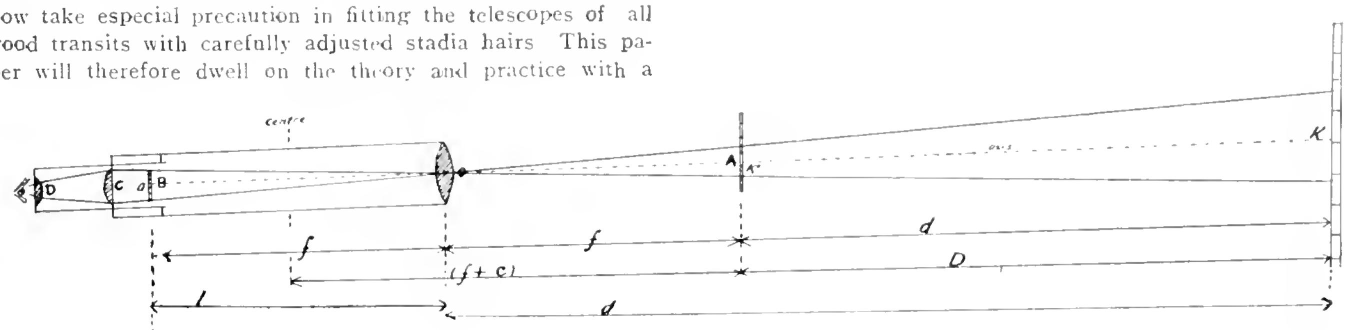


Fig. 1.

The Transit Telescope.—We find that according to the laws of optical science, an image, of any object to which the telescope may be directed, is formed within the tube, and there magnified by an eyeglass or eye pieces composed of several lenses. Any object is rendered visible by every point of it sending forth rays of light in every direction. Those rays of light coming from the object are bent in passing through the object glass. It is the law of light rays to move in a straight line when not obstructed. The best exposition of the relation of light to image is shown by the so-called pin-hole camera. There being no lens, there is no obstruction to the rays of light coming from the object photographed, and passing through the tiny pin-hole of the camera are therefore free from distortion, and are perfectly pictured on the negative, in an invented position, of course. Just as is the image passing through the object glass of a telescope, as the rays of light intercepting one foot on a rod, one hundred feet from the telescope, and passing through the object glass to the cross-hairs, are so nearly parallel, and come so near to each other that they are almost in line of colleimatem scarcely unaffected by the convexity of the object glass. For, by a principle of optics, the rays from any point of an object converge to a focus at such a position that a straight line, called a secondary axis, connecting the point with its image passes through the centre of the lens, and the point of intersection is called the optical centre. From this it follows that lines drawn from the stadia wires, through the centre of the object glass, will intersect the rod at points corresponding to those which the wires cut on the image of the rod (Fig. 1). On these underlying principles are based the law of stadia measurements.

Fig 1 represents a telescope which inserts the object. In the figure the highest and lowest points of the rod are intercepted by the stadia wires, are alone considered. The upper and lower rays shown, proceeding from the rod in meeting the object glass, O, form a cone. The longitudinal section appears only in the figure (Fig. 1). It will be seen that these rays, after passing through the object glass, cross one another and thus form, at B, an inverted image of the rod. The rays forming this image continue onward and pass through the two lenses C and D, which act like one magnifying glass, so that the rays, after being reflected by them, enter the eye at such angles as to form there a magnified and inverted image of the rod K. Fig. 2 represents a telescope which shows objects erect. Its eye pieces has four lenses. It will be seen that an inverted image of the arrow A is formed at B, as before, but the rays continuing onward are so refracted in passing through the lens, C, as to again cross, and after further refraction by the lenses D and E to form, at F, an erect image which is magnified by the lens G.

That shown, Fig. 1, which shows the object inverted, is preferred for stadia work. The erecting eye pieces absorb light and lessen the distinctness of vision. A little practice accustoms the observer to seeing his rod man standing on his head, without becoming alarmed, and to motion him to the right when he wishes him to go to the left and vice versa. What makes it difficult to understand the principles of stadia measurements is that the image of the rod, or any object, is not seen at the vertical position of the cross hairs at all; for the image of the cross hairs (and the rod intercepted by them) is optically projected beyond the objective to the extent of the focal length of the latter. The image of the cross hairs, at B, Fig. 1, is optically projected at A. The rays converge at that point, and measurements must naturally be taken from there.

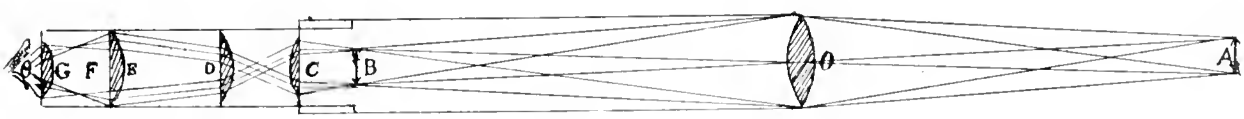


Fig. 2.

The Reduction of Stadia Notes.—For stadia measurements with inclined sights two methods of procedure are in use. One to hold the rod at right angles to the line of sight, the other to hold it vertical. With the first method it will be

seen by referring to Fig. 3 that the distance rod is not to the foot of the rod E, but to a point F' vertically under the point F, cut by the centre wire. A curveline has therefore to be made for this. An objection to this method is the difficulty of holding the rod at the same time in a vertical plane and inclined at an angle proportionate to the angle of elevation of the telescope. The method adopted usually is the oblique view of the rod:

Oblique View of the Rod, Investigated Trignometrically.

FIG. 4 a = distance of stadia wires apart.

f = principal focus of telescope.

$\frac{f}{a}$ = K^1 = constant, and generally made equal to 100.

A B = K the reading in the rod.

M F = d the inclined distance = $(f + c) + G\,F = (f + c) + K^1\,C\,D$.

M P = D, the horizontal distance, d cos. n.

F P = Q = the vertical distance, D tan n.

A G B = 2 m

Vertical angle = n

Then :—

$$\frac{A\,F}{G\,F} = \frac{\text{Sin } m}{\text{Sin } \left[90^\circ + (n - m)\right]}$$

or

$$A\,F = G\,F\ \text{Sin } m\ \frac{1}{\text{Cos } (n - m)}$$

and

$$\frac{B\,F}{G\,F} = \frac{\text{Sin } m}{\text{Sin } \left[\,90^\circ - (n + m)\,\right]}$$

or

$$B\,F = G\,F\ \ \text{Sin } m\ \frac{1}{\text{Cos } (n + m)}$$

$$\therefore\ AF + BF = GF\ \text{Sin } m \left(\frac{1}{\text{Cos } (n - m)} + \frac{1}{\text{Cos } (n + m)}\right)$$

$$A\,F + B\,F = K, \text{ and } G\,F = \frac{C\,D}{2}\ \frac{1}{\tan m} = \frac{C\,D\ \text{Cos } m}{2\ \text{Sin } m}$$

By substituting, and advancing to common denominator.

$$K = \frac{C\,D}{2}\ \frac{\text{Cos } m\ [\ \text{Cos } (n + m) + \text{Cos } (n - m)\ ]}{\text{Cos } (n + m)\ \text{Cos } (\ n - m)}$$

Reducing this :

$$C\,D = K\ \frac{\text{Cos}^2\ n\ \text{Cos}^2\ m\ -\ \text{Sin}^2\ n\ \text{Sin}^2\ m}{\text{Cos } n\ \text{Cos}^2\ m}$$

$$\text{as } d = M\,F = (f + c) + K^1\,C\,D$$

$$\therefore\ d = (f + c) + K^1\,K\ \frac{\text{Cos}^2\ n\ \text{Cos}^2\ m\ -\ \text{Sin}^2\ n\ \text{Sin}^2\ m}{\text{Cos } n\ \ \text{Cos}^2\ m}$$

The horizontal distance D = d Cos n.

$\therefore\ D = (f + c)\ \text{Cos } n + K^1\,K\ \text{Cos}^2\ n - K^2\,K\ \text{Sin}^2\ n\ \tan^2\ m.$

This third number of the equation may safely be neglected, as it is very small even for long distances, and large angles of elevation. At 1500 feet with angle n equalling 45 degrees, it is but 0.07':

Therefore, $K^1\,K\ \text{Sin}^2\ n\ \tan^2\ m = AB\,\frac{\text{Sin}^2\ n}{\text{Cos } n}\tan^2\ m = O$ approximately and the final formula for distances with a stadia rod kept vertical and with wires equidistant from the centre wire, is the following $D = (f + c)\ \text{Cos } n + K^1\,K\ \text{Cos}^2\ n$ (1)

and the vertical distance 2 = D tan n.

$$\therefore\ Q = (f + c)\ \text{Sin } n + K^1\,K\ \text{Cos } n\ \text{Sin } n$$

$$= (f + c)\ \text{Sin } n + K^1\,K\ \frac{\text{Sin}^2\ n}{2} \qquad (2)$$

When $K^1 = \frac{f}{a}$ focal distances, divided by distances apart of stadia hairs, and K = distance interrupted by stadia hairs in the rod.

By the above formula (1) and (2) both the horizontal and vertical distances can be immediately calculated when the reading from a vertical rod, and the angle of elevation of any sights are given. Tables, however, provide this data, saving the tedious calculations.

As regards the addition of the constant (f). Several suppositionary opinions have been advanced on the subject, each of the following having its advocates:—The common apex or point of convergency—principal focus—of the rays of light forming the two similar triangles, is:—The centre of the instrument; the stadia hairs; and the front face of the objective; none of which are really correct. The point towards which the rays of light converge when they emanate from a point at a distance from the lens vary according to that distance.

When the rays proceed from a point so distant that they may be considered parallel rays, they are refracted and converge to a point in the axis of the lens called the focus, or the principal focus, at a certain distance from the lens called the focal length of the lens, this distance depending upon the radii of curvature of the surfaces of the lens. In the figure the reason why the image is formed at distance F in front of the object glass is because the image of the cross-hairs is optically projected beyond the objective to the extent of the focal length of the latter. The rays converge at that point, and the measurement must be taken from it. Therefore, in order to obtain accurate results a constant must be added to the reading from that point. The constant

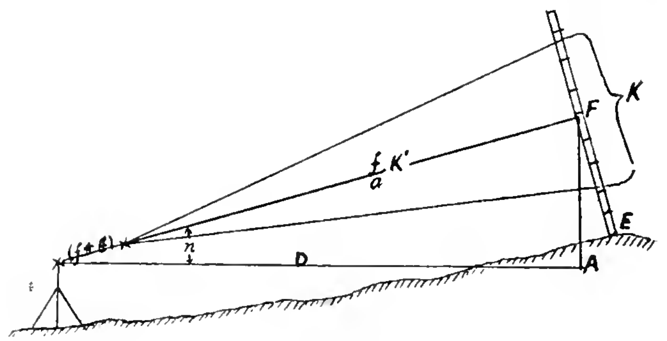


Fig. 3.

is equal to the focal length of the objective plus the distance from the object to the centre of the instrument; second, when the rod is always held vertical. But owing to this oblique view of the rod, it is evident that the space intercepted by the cross-hairs on the rod varies, not only with the distance, but also with the angle of inclination of the sight. In order, therefore, to obtain the true distance from station to station and its vertical and horizontal components, a connection must be made for this oblique view of the rod.

Page 17—The conclusions, therefore, are that as through the focal changes with distance (however slight) to the extent of .0052 ft. from 100 to 500 feet sights, it is plain that hairs adjusted at a distance of 100 feet will read correct distance at 500 feet, to the limit of (.0052—a). This would be somewhere like three inches. Not very much of an error, yet a needless one, and an error which may be partially if not wholly overcome by adopting a constant for each particular instrument, and not making the rule apply to an instrument by measuring. Each instrument has an individuality of its own, and must be adjusted by actual trial, and by making these adjustments, that is, adjusting the stadia hairs at a mean distance, not at 100 feet, nor yet 500 feet, but a mean distance between these, say at 300 feet, the difference of focal length is thus reduced one-half, or, for an 11-inch telescope of 30 magnifying power, the change in focal length at from 100 to 300 would be but .0027 ft., so that it will be possible to read all lengths of sights, from 100 to 500 feet to an almost perfect degree of exactness. This is refinement indeed, that, on rough ground, no chain measurement can approach, if on level ground in a series of distances. Once

the instrument is thus correctly fitted with fixed hairs, this refinement may be relied on, by always observing carefully and accurately.

General Uses of the Stadia.—For taking topography in country that will not permit a plane table; for coal drop line surveys, preliminary railway locations; for land surveys.

The Transit.—The instrument best suited for stadia surveying is an accurate transit with full vertical circle rigidly attached to the axis of the telescope and graduated to minutes from 0 deg. to 90 deg. in both directions. It should be provided with two double verniers attached to the horizontal vernier arm, the zeros of the two verniers being in a horizontal plane when the instrument is levelled up.

The horizontal limb should read also to minutes, there being no advantage in a reading of 30 sec. as the reduction tables, usually, do not reduce seconds. The graduations should number from 0 deg. to 360 deg. The graduations for the needle should also be numbered from 0 deg. to 360 deg., in opposite direction to the horizontal limb, and not be divided up in quadrants. This is important because in taking topography, for example, on either side of a railway line, the magnetic reading will approximately correspond with the horizontal vernier readings, and the needle only may be read which will greatly accelerate the work in hand. For very accurate work it is recommended to have a level attached to the vernier arm of the vertical circle. It will be found very convenient and probably more precise, than having to bring the telescope level to zero.

As between fixed or adjustable stadia hairs, it is immaterial so long as the rod reading is correct. Fixed hairs, however, are preferred for stadia work on the ground that errors due to variation of the wire interval are avoided, and a better focusing of the eye-piece.

An inverting telescope is to be preferred as it gives a wider field and a more sharply defined image. The eye-piece, known as the "Ramsden" eye-piece, and is termed a positive eye-piece, consisting of two plano-convex lenses, the convex-cut faces of which are turned toward each other. It is called an "inverting" eye-piece, but is not really so, as it is the object glass that inverts the image of the object viewed, and the eye-piece picks up the image in its inverted position. To get an equal clearness of vision with an "erecting" eye-piece as with a Ramsden, or "inverting" eye-piece, a correspondingly larger object glass must be used.

Stadia Rods.—For stadia work a self-reading rod is to be preferred, though for sights of 500 to 1,000 feet a target is necessary. It is quite impossible to read a rod accurately at 1,000 feet that has no target, even with a telescope magnifying 30 to 40 diameters. With a good target rod this distance can be read, in an ordinary atmosphere, quite accurately. But as distances of one to five hundred feet are most common a self-reading rod, divided into units, is best and handiest. As good a stadia rod as any is the "flexible," or tape rods tacked on to a light board twelve feet long. These tapes are made of prepared canvass, are strong and weather proof, and are convenient to carry. They are manufactured by Keufell and Esser, New York. The rod, or board, to which they are tacked should have a hinge in the middle for convenience in carrying. A certain distinct mark, easily seen at a distance, should be made or attached to the rod at the average height of the instrument, in order to get correct elevations. While this "height of instrument," marked on the rod in this way may not correspond to all heights of the instruments, it will, however, be an average height, and these average heights will correct themselves. In case the absolute height of the ground under the instrument, the height of the telescope at each station will have to be measured by the rod, and the difference between this measurement and the average height used in sighting to the rod either added or subtracted as the case may be. The difference will ordinarily be so small, that in a great deal of stadia work no reduction will be necessary.

In sighting to the rod for the angle of depression or elevation, the centre horizontal wire must always be used. A level should be used in the rod surveys, where the value of the land is not too high—say less than $50 an acre. In fact, any place where location and elevation are required at the same time. We would not regard it as accurate enough for city lot surveying, nor convenient where it is necessary to put in stakes at regular intervals of 50 or 100 feet.

We would hesitate to use stadia in a lost boundary suit, or in any place where it would be necessary to convince a jury that the work was accurate, although we feel that more accurate work can be done in rough country with stadia than with tape line providing care is used. Owing to the great chances of error we never feel satisfied with a line until it is checked by another line having a common beginning and ending. In taking topography over a large area the transit line will necessarily cross or join, so this checking takes little extra time.

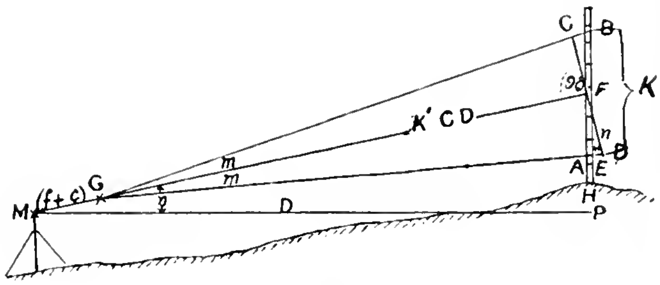


Fig. 4.

Fairchild and Gilchrist of Philadelphia, wrote the writer: "We find that errors balance; lines 10 miles long may check for elevation within a foot at the ends; and cross lines between be out as much as five feet. In the horizontal plane these errors generally do not vary so much. We consider a horizontal tie of lines between 2 and 20 miles long of 5 feet out, good; 10 feet, fair; 15 feet, questionable; and 20 feet, bad. This in a fair country. We should avoid steep sights rather than long sights, and try to get sights of average length on main transit lines. But if one can avoid a steep sight by taking a short fore-sight and long back-sight, or vice-versa, do so.

"Lengths of sights depend upon the atmosphere and the glass in the transit. Under fair conditions sights of 500 feet is good; 400 feet is a little better; 600 feet at pinch on main line; on side shots, 1,200 feet long is not uncommon.

"We add (f+c) to each rod reading, and then reduce for horizontal and vertical. The error in this is so slight that it can be disregarded. (f+c) is variable with each transit. It is important that transit be accurately adjusted, particularly plate bubbles. Only one sight is necessary. A level—a small round bubble level—is easily attached to the rod, and the rodman keeps the rod plumb by watching one bubble. Slide rods should be avoided, and a target, except for long sights, is unnecessary."

Preliminary Railway Surveys by the Stadia Method.—In making preliminary location surveys for roads or railroads, the stadia method enables the surveying party to go over the field much more rapidly, and in most cases is a cheaper method for that reason than using a level. Locating engineers, however, seem to have a decided preference for using a level for this work, chiefly because of the more ac-

curate data obtained. It would seem to be useless refinement to go over the ground with a level taking precise but tedious readings at every station, when these levels are usually only furnishing rough data to the engineer from which the final location can be determined. In a level country or on gently undulating ground, the final location can often be determined with no preliminary observations, and the levels for grade fixed from one survey, but usually all the work of the preliminary survey must be done over once, and often many times, before the line is finally located. The stadia method is a simple and rapid way of obtaining all the necessary data with sufficient accuracy for the purpose intended since both the topography and the bearing of the tangent can be found with one setting of the instrument.

It would seem that instead of having to make two or more preliminary surveys of a railway line, that one fairly careful reconnaisance be made over the ground in the first instance, taking the data of all elevations and depressions on either side to the distance of 500 to 1,000 feet, that the preliminary line that would follow would approximately be a location line, thus saving one or more preliminaries.

In adopting the stadia method we make a compromise between reconnaisance and preliminary, and this is perhaps what is needed. Our usual reconnaisances are too limited in data, trusting to what may be obtained with hand level, compass and aneroid, while our preliminaries are necessarily of too great refinement. The stadia, then, offers a solution—a compromise between reconnaisance and preliminary, in which in a good country no preliminary may be needed but the final location made from the stadia, while in rough country a preliminary will be needed, and one approaching in refinement, a regular location.

The stations in a stadia survey need not be placed exactly one chain apart, but can be taken 200 ft., 500 ft., or even 1,000 ft. apart if the ground is level. After setting up the instrument at a station, and getting a back-sight, the telescope can be circled round in azimuth and all the topography taken on either side of the line. The rodman can be signalled to place his rod where wanted and the angles of all hills and valleys within 1,000 feet be obtained. In long sights, three observations (in rough country) on either side of the line are needed, one between 0 deg. and 90 deg., one at or about 90 deg. from the tangent, and one between 90 deg. and the fore-sight. The elevation and distance of the next station should then be taken, and finally three more observations recorded for the topography on the right of the line, one between 180 deg. and 270 deg., one at 270 deg., and one between 270 deg. and 360 deg. The deflection angle, if any, must also be read on the horizontal vernier, while the side shots need only be read by the needle, this saving a lot of time. Progressing rapidly in this way the topography of the country through which the road is to pass can be plotted with reasonable accuracy. Ordinarily a couple of side shots will be sufficient. The rodman should carry small pegs or hubs to drive at the stadia stations, and on the points taken on the tangent or main line. The axman drives stakes beside the hubs in the same way as on railway hubs.

Reducing Stadia Readings.—When working in the field with a stadia, a stadia rule, as Colby's, or a cheaper one, Keufel and Esser's, or, perhaps, what is better, graphic diagrams, should be carried for making the corrections for differences of elevation, or $\frac{1}{2}$ Sin. 2θ (of observed angle), and, also, corrections for distance, Cos.^{2} θ. The constant of the instrument (f+c), may or may not be reduced to sine and cosine for small angles. The stadia rules are more convenient to handle than tables, and the graphic diagram, if made accurately, are even easier read. Any good draughtsman can easily prepare a diagram for Cos.^{2} θ, and Sin. 2 θ, from which corrections can be read direct for any observed angles and distances.

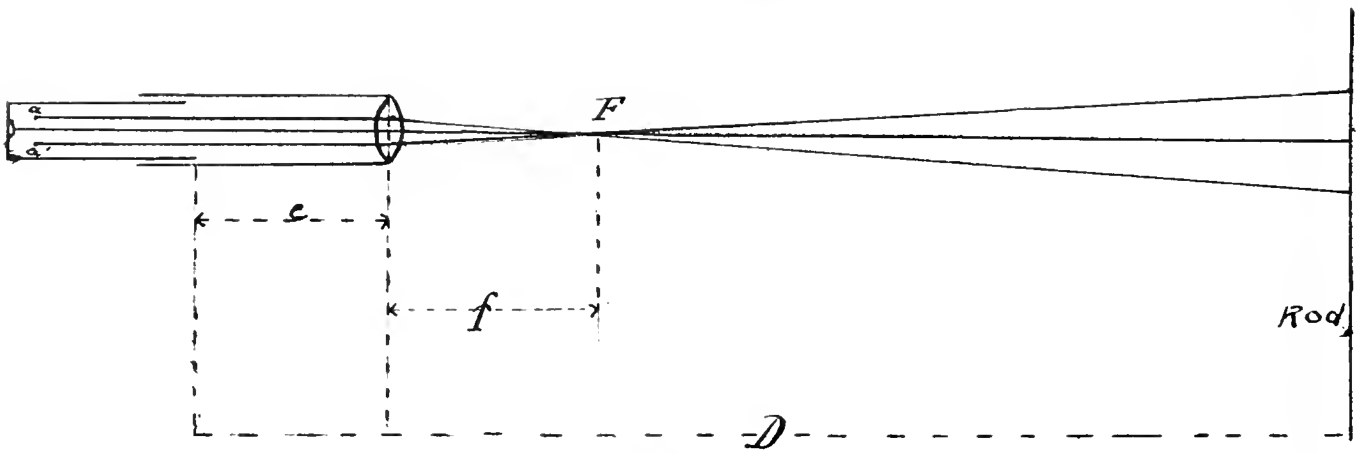


Fig. 5.

Keeping the Notes.—The most difficult part of a stadia survey is keeping notes in handy form. Books can be obtained which are ruled especially for stadia work.

Both the left hand and right hand pages are used and little room is left for the sketch on the ordinary size field books. Since the stadia reading must be corrected for differences of elevation it is perhaps better to enter the observed vertical angles and leisurely reduce with tables. The distance, however, should be reduced on the spot so as to mark on the stakes.

CONTRACTORS' WORKS IN CANADA.

Sir W. G. Armstrong, Whitworth, and Company, Messrs. Swan, Hunter and Wigham Richardson, and Messrs. Cammell, Laird and Company are negotiating for suitable sites for shipyards in Canada. Messrs. William Harkess and Sons, of Middlesborough, intend to open an establishment at Halifax, N.S., while Messrs. Denny, of Dumbarton, Messrs. John Brown and Company, the Fairfield Company, and Vickers, Limited, Barrow, are busy laying down plant at various places in the Dominion. The last-named firm also propose to build vessels at Sault Ste. Marie, an important point on the Great Lakes. So far, no decision has been arrived at by the Borden administration in regard to the request made by Canadian shipbuilders for further state assistance, but it is expected that the import duty on materials will be removed.—From Contractors' Chronicle.

EXHAUST STEAM AND ITS UTILIZATION.

By J. M. Gordon.

In the last issue of *The Canadian Engineer* we dealt with the utilization of exhaust steam in a paper by the above author which space did not permit us to publish in full. The latter portion of his paper, which deals more particularly with condensers and turbines, we take pleasure in publishing herewith.

The advent of the steam turbine has greatly influenced the design of the condenser, for in previous days any condenser giving a vacuum of 25 inches was considered all that was necessary; but nowadays the demand for high vacua has resulted in a condenser of far greater efficiency. In the use of condensers in mining plants a main difficulty is that the cooling almost invariably employed is derived from the mines. Such water is rarely below 56° F. This necessitates a large volume of water passing through the condenser; in fact, as much as can be economically allowed. Consequently, if the quantity of water is a factor of consideration, it will be essential to erect cooling towers or sprays, with settling reservoirs, as the temperature of the outlet water has such a bearing on the vacuum; in fact, some British engineers prefer expressing the vacuum from condensers by temperature, rather than by inches of mercury. Referring to Fig. 3, it will be found that each inch from 25 inches to 27 inches is equivalent to 4 per cent. consumption by the turbine; that between 27 inches and 28 inches, about 5 per cent., and from 28 inches to 29 inches, from 6 to 7 per cent.; or that approximately 3° F. difference in the temperature of the exhaust means about an increase or decrease of 1 per cent. in the consumption. This will demonstrate the importance of having the temperature of the outlet water as near as possible equal to the temperature due to the vacuum. The difference in a good modern condenser should not exceed 5° to 6° F. when condensing 12 pounds per square foot per hour. Another method of considering the efficiency of a condenser is by expressing it in B.T.U.'s transmitted per square foot of cooling surface per hour for 1° F. difference of temperature. In well-constructed surface condensers, such as Parsons, it can be as high as 1,200 B.T.U.

In the surface condenser the resistance to the heat absorbed from the steam by the water may be considered in three stages. In the first stage we have the transmission of the heat from the steam to the tubes of the condenser. This transmission is governed by the efficiency of the air-pump and by the quantity of air in the condenser. These factors can be greatly reduced by dry air-pumps or by the more recent method of the application of the Parson vacuum augmentor, which withdraws the air completely from the condenser. Air in a condenser is detrimental, since it not only vitiates the vacuum, but it also blankets the tubes and retards the transmission of heat. The second resistance is small, and hardly worthy of consideration. It is due to the metal of the tube. The third and last, but not least, resistance, is the final transmission of heat from the tube to the water. Should there be a crust of slime or carbonate on the tube the conductivity of heat drops considerably, and the efficiency drops. It is essential to keep the water in a violent state of excitement in order to prevent it having a clothing of temperatures. In recent years the application of Parson's augmentor has greatly improved the condenser. The augmentor is simply a set of steam pipes which sucks the vapor and air from the main condenser and delivers it through a small auxiliary condenser to the air pump. In practice this augmentor has been known to bring the conductivity from about 250 or 300 to between 800 and 1,000, or reduce the temperature from 26° F. to 5° F., a gain in temperature of approximately 21° F., or 7 per cent. in the total steam consumption of the turbine. This steam jet consumes 0.6 per cent. only of the amount of steam consumed by the main prime mover. In Scotland Korting Bros.' ejector condenser has been used in connection with mixed pressure turbines, and has proved eminently successful.

Discussing now the main prime mover, the turbine itself, we have a machine possessing many peculiarities and differing vastly from the old reciprocating engine. One of the chief differences is the mode of lubrication. In most types of mixed pressure turbines the bedplate is the receptacle for holding the oil, out of which it is pumped through the bearings, and thence through an oil-cooler, and again back into the bedplate. Thus the oil is used over and over again. These turbines are usually governed by centrifugal governors directly coupled to the shaft and in direct communication with the tachometer, working a trip gear, which in turn opens and closes the high-pressure nozzles according to the weight of load and supply of exhaust steam.

There are quite a number of mixed pressure turbines on the market; in fact, all compound steam turbines are adaptable for exhaust and mixed pressure use. The single stage, or De Laval turbine, is not adaptable, as the efficiency is regulated by the speed, the higher the speed the higher the efficiency of the machine, and it has been found that units

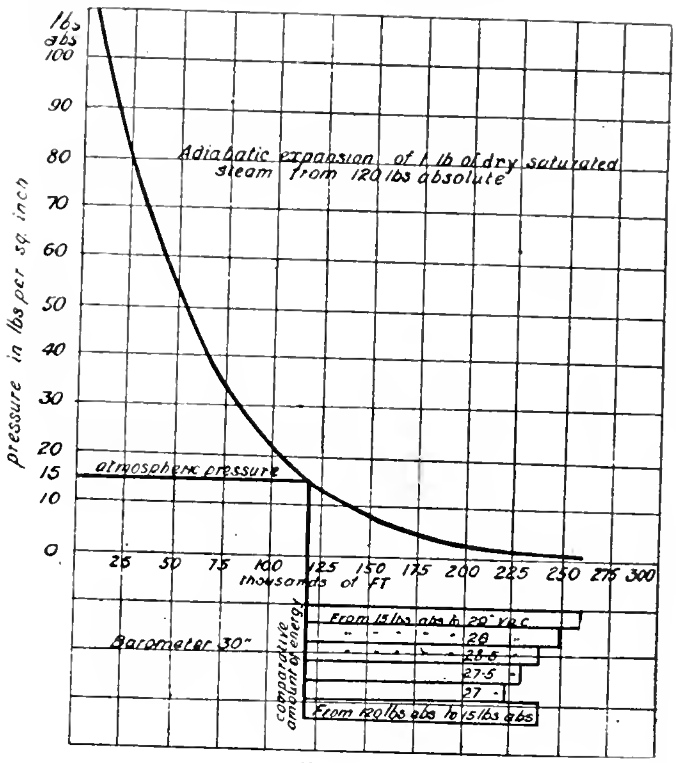


Fig. 3.

of from 200 to 300 kw. is about the highest economically obtainable. These sizes run with a periferal speed of about 1,200 per second, which is about the limiting velocity, for above this, centrifugal forces become too great. Another disadvantage is that the periferal speed being so high the turbo-generator cannot be directly connected to the machine, but has to be geared down.

The compound-stage turbine, as already mentioned, is divided into two sub-classes, namely, the reaction and a combination of impulse and reaction. In the first sub-class we have Parsons, while in the second we have the Rateau, Zoelly, Curtis, Bergman, Riedler, Stumpf, Sulzer and Echer-Wyss. The first sub-class being the first type to be constructed had to contend with the fierce cutting action of superheated high-pressure steam on the blades; and to reduce this action as far as possible, the expansion is divided into a number of stages, thus reducing the velocity of the steam, while also reducing the high periferal speed and revolutions. Mean-

while metals or alloys have been discovered to withstand this high eroding properties of superheated steam jets at great velocities; and there is now in the market a combination of the impulse and reaction turbine with very few stages.

Without discussing the details of the respective types, a short resumé of the better known turbines will not be out of place.

The Parson turbine consists of a long cylindrical drum, increasing in diameter by stages from the high to the low-pressure end. This drum is mounted on a shaft revolving in two pedestal bearings, and the whole is enclosed in a cast-iron casing. On the perifery of the rotor are placed alternate rows of fixed and rotating blades or vanes. These blades are fixed in dovetail grooves with distance pieces placed between them and cranked into position. The increase in size of the blade in the low-pressure end requires it to be stiffened by shrouding. The fixed blades project inwardly, while the revolving blades project outwardly. The steam enters in the bottom of the high-pressure end of the cylinder, leaving the top clear of steam pipes, thus much facilitates dismantling. The steam first passes through a ring of fixed or guide blades, and in so doing the pressure falls and proportionately the velocity of the steam rises, and is then projected in a rotational direction against the neighboring ring of rotating blades, whereby work is done upon the blades, and hence the acceleration of the rotation of the turbine. This is carried on through the different stages until the steam is fully expanded, and it then exhausts into a condenser.

In this type of turbine the steam, in addition to giving a rotational force, exerts an end-wise pressure along the

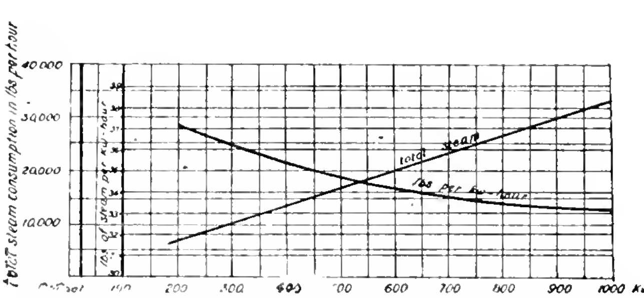


Fig. 4—Consumption of Steam by an Exhaust Steam Turbine. Vacuum 28″ (Bar 30″).

shaft, on the surface of the blades. This is now counteracted by dummy pistons for the different stages or sections, each presenting an area equivalent to the mean blade area of the section it is intended to balance. Thus the turbine shaft runs in complete balance endways, and after the critical speed has been reached the shaft can be moved backwards and forwards with a lever with comparative ease. A claw type of flexible coupling is usually used for connecting the turbine with the generator to allow for any slight difference in alignment. A thrust block is placed at the steam end of the turbine shaft to give the proper clearances and adjustments between the fixed and moving blades. In the small sizes of Parsons turbine the shaft is usually made from a solid steel forging, but in the larger sizes hollow steel drums, which are machined both outside and inside, are fitted together and carefully shrunk and pinned. The lubrication of the bearings, thrust-block and governor gear is automatically performed by a rotary pump driven from the worm-wheel of the centrifugal governor; and, as it is placed low down, it is continually flooded; hence it is almost impossible that it would fail to perform its function. The main bearings are made of gun-metal. The bushing is held in position by a loose-fitting dowel, and is surrounded by three concentric tubes, the annular spaces being filled with oil in order to damp vibrations; this causes the bearing to be practically self centring.

The Sulzer turbine consists of a partially injected impulse turbine for the high-pressure stage, and of a fully injected reation turbine for the low-pressure stage. The blades of the impulse wheels are made of a high-grade nickel steel, while the reaction blades are made of a special bronze. Unlike other turbines, this type does not make an oil well of its bed-plate, but has a special vessel usually kept in the basement of a power-house. This is a precautionary measure against the possibility of grains of sand finding their way into the oil. In order to obtain oil when the turbine is at rest a small steam auxiliary oil pump is provided, which is usually attached to the bed-plate. A device is provided in the turbine to make it impossible to start the turbine before the complete oil system (governor, bearings and balancing disc) is under pressure. In this type of turbine, in sizes up to 1,500 horse-power, an ordinary collar bearing is used to take up the axial thrust, but in the larger sizes a small oil-pressure balancing disc is used which is attached outside of the high-pressure bearing, and is keyed on the shaft.

The Curtis turbine, like the Parsons, is made by more than one firm in different countries. In Germany, a very excellent type of the Curtis mixed-pressure turbine is made by the Allgemaine Elektricitats-Gesellschaft, while in Great Britain the British Thomson-Houston make a unique high-pressure Curtis turbine with the generator directly above the power producer, the low and mixed-pressure type being of the horizontal construction.

In this type of mixed-pressure turbine the expansion is performed in two stages. The first expansion takes place in a row of nozzles, which brings the steam down to approximately atmospheric pressure, and its energy is then taken up by the turbine wheel, usually comprising two rows of buckets with two velocity stages. From this point the steam is exhausted into a chamber and there passes through a second series of nozzles into the low-pressure end. This second series of nozzles is divided into two sets, one set conducting the exhaust steam from the high-pressure stages, and the other set conducting the exhaust steam from the accumulator. These sets are so constructed that the exhaust steam in the accumulator gets the preference, and it is only when the load becomes too great, or the exhaust steam fails, that the turbine slows down, or rather the tendency to do so causes the governor to open the high-pressure nozzles to the amount of the deficiency; and, as soon as the exhaust steam from the generator can take the whole load, the governor once more closes the high-pressure nozzles. The governor is usually set for a speed regulation of 2 per cent. between full and no load, with a maximum monetary variation of 4 per cent. for the purpose of synchronizing and making the turbine bear a proportional share of a peak or sudden extra load. An emergency governor is also fitted to this turbine, so that at any time, should the main working governor fail, and the turbine increase to 15 per cent. above the normal speed, a trip-gear would act and cause the throttling of the valve in the main steam pipe until such a time as the normal speed was again reached.

These low-pressure and mixed-pressure steam turbines are usually directly coupled to a three-phase alternating generator. Three-phase alternating current is almost universally adopted because of the economies in the transmission lines, while also three-phase induction motors are admirably adaptable for pumping work and haulage. The great disadvantage the system once had was the sudden drop of voltage on the main alternator, when a fluctuating or a peaky load was encountered, such as occasioned by one or two haulage motors commencing operation on or about the same time. This difficulty has been overcome by automatically varying the resistances in the exciter field through solenoids actuating moving contacts.

Low-pressure turbines have also been applied to rotary air compressors, and are found economical when the demand

on a reciprocating air compressor exceeds the supply. By so utilizing the exhaust steam of the reciprocating set the rotary set will supply air at 30 pounds absolute to the main compressor, and thus almost double the output of the main set with no more steam than was used previously.

The capital or initial costs of a high-pressure set and a mixed-pressure set are compared in the following table. The operating expenses for a twelvemonth at an average deep colliery where exhaust steam is plentiful are also computed. As the plant under construction is of two units, each of 1,000 horse-power, the reciprocating engine is not considered:—

Capital Costs.

Plant 2, 750 Kw. Sets.	H.P.	M.P.
Power-house and crane	$ 8,250	$ 8,250
(2) 750 kw. turbo-generators, complete	50,400	60,000
Complete installation of two condensing sets	15,000	23,000
One cooling plant	4,000	6,500
Battery of boilers with essentials.....	30,000	....
One regenerator	....	8,000
	$107,650	$105,750

Annual Cost Sheet.

Plant instld. 2, 750 kw. sets. H.P. Condenser 26 kw..... M.P. Condenser 50 kw.....	High Pressure	Mixed Pressure	High Pressure $	Mixed Pres. $
DAY SHIFT PER ANNUM 288 Working days of 8 hours = 2304 hours at 600 kw. per hr. = 1,382,400 + condenser = 1,442,300 1,497,600	1,442,300	1,497,600		
AFTERNOON SHIFT (Same as Day)	1,442,300	1,497,600		
NIGHT SHIFT 288 working days at 8 hrs... 2304 hours at 250 kw....... =576,000 + condenser....	635,900	691,200		
GRAND TOTAL OF UNITS	3,520,500	3,686,400		
DITTO, OF USEFUL UNITS	3,340,800	3,340,800		
	Heat Pres.	Mixed Pres.	Heat Pres.	Mixed Pres.
Coal consumption per annum in metric tons at the rate of 3.4 lbs. of coal per kw. hr. when mixed pressure turbine runs on 6-hr. live steam on the night shift....................	TONS 5,670	TONS 730		
COST:				
Price of coal at $4.00 per ton			$22,680	2,920
Int. at 5% on capital outlay			5,380	5,280
Depreciation at 10%......			10,576	10,575
Boilerhouse attendance.....			2,500	600
Enginehouse attendance....			3,000	3,000
Oil waste and stores......			300	300
TOTAL COST PER ANNUM			$44,625	22,675
COST PER USEFUL UNIT			1.33 cts.	0.68 cts.

Advantage for Mixed Pressure Turbine, .65 Cents per Useful Unit.

In conclusion, an interesting instance in support of the foregoing argument may be here cited. In the power station of the Edinburgh Corporation, Scotland, were eight Willin & Beliss engines, each of 1,200 horse-power, designed to operate with a 25-inch vacuum; but because of a lack of water these engines were not operated non-condensing. Mr. P. S. Mitchell, of Glasgow, Scotland, collected the exhaust steam from four of the engines and installed two Rateau low-pressure turbines with a Brown Boveri, D.C. combination at 490 to 500 volts. Each of these turbines is capable of developing 1,250 kw. when supplied with 45,600 pounds of exhaust steam per hour. Two of the reciprocating engines have a total output of 1,550 kw. Consequently the output has been increased no less than 80 per cent. by the utilization of what was formerly waste steam. The condensers installed were the contra-flow condensers made by Richardson & Westgarth, and it is interesting to note that this Scottish engineer had the boldness to use the sewage water of the city of Edinburgh for circulating purposes.

OPERATION OF TRAILERS IN CONNECTION WITH PEAK LOAD CITY SERVICE.

A description of the operation of trail cars in Cleveland is given by Mr. G. L. Radcliffe, general manager of the Cleveland Railway, in a recent number of the Electric Railway Journal. The article deals principally with the changes made in equipment since the trail car was last in general use.

With adequate motors and improved tracks, its operation is no longer hazardous; its application to traffic problems is definite and easy. No more a makeshift, but specially designed to meet certain conditions, it is in every way a worthy running mate for the modern motor car. The first modern trailer operated on the system of the Cleveland Railway Company was placed in service September 16th, 1912. One hundred are now on our lines, and a second hundred will shortly be added. The operating features of this equipment necessitates a brief description of the car itself.

The extreme length is 49 ft., and there is no platform or vestibule at either end. A continuous longitudinal seat completely encircling the interior gives a maximum seating capacity of seventy-two and leaves a very large area for standing passengers.

The cars are mounted on Brill No. 67-F trucks, with 22-in. wheels, bringing the floor of the trailer close to the ground and making entrance to the car easy. It is but one step from the ground into the car—15 in.—and a second step of the same height to the car floor proper.

There are two doors in the centre of the car, one for entrance, the other for exit. The fare-box is placed opposite the post which separates the doors. The conductor's position at the box is facing the rear, so that an aisle is open between the fare-box stand and the devil-strip side of the car. The stand supporting the fare-box has a small shelf for change, on which is mounted a set of push buttons to govern the doors. Each door is opened and closed by compressed air electrically controlled by the conductor through the push buttons. The opening and closing of the doors flashes signals to the motorman by an electric contact, which should make trailer operation much safer than when he is entirely dependent on the signal bell.

The trailer is pulled by a 38-ft. motor car, equipped with four 40-h.p. motors of the Westinghouse 307-F type. The train is equipped with Westinghouse semi-automatic brakes and is coupled with the Tomlinson automatic air coupler. The couplers, while not yet entirely perfect, are a great improvement over the couplers in general use on the old-type train. Cars equipped with the modern automatic air coupler can be coupled much more quickly and with much less danger to the employee than formerly, while the application of air brakes to both cars reduces very largely the danger of accidents through the heavier equipment. These two features, we believe, with the electric signal device, give the requisite safety both to employees and the public.

When these trailers were first put in operation it was decided that we should use them only during the rush hour, morning and evening, and that trains would be left coupled so that it would not be necessary to switch, couple and un-

couple them several times each day. This method of operation is still pursued, and at present the motor cars are laid up during the greater part of the twenty-four hours. Upon the arrival of the next hundred trailers, however, it will be necessary for us to uncouple the trains in order to have the use of the motors during the day.

The first, and probably the greatest, advantage in operating trailers is in the cost of equipment. It will readily be seen that the elimination of motors and other electrical equipment from the car greatly reduces the cost of the equipment necessary to move rush-hour traffic, and the investment in idle equipment is smaller in proportion.

A second advantage is the carrying capacity of the trailer. In our case it is about twice that of the motor car. Seating seventy-two, while the motor seats but thirty-eight, the arrangement of seats noted earlier in this paper gives the trailer a standing area even larger in proportion than the similar area in the motor car. Thus, while the seating capacity of one of our trains is 110 passengers, we have carried over 350 passengers on a rush-hour trip, and it is not unusual to find 200 passengers on one trailer.

Another advantage is the reduction in operating costs made possible. The heavy extra loads just mentioned require the addition of only one man to a crew to handle, the trailer being in charge of one conductor and the train manned by the regular crew.

All the cars on the system of the Cleveland Railway are equipped with fare-boxes, and most of them are operated on the pay-enter plan. When the trailers were adopted it was intended to operate them also as pay-enter cars, but on account of the single-entrance and no-platform features it was found that loading took too much time and the method was changed so as to utilize the rear half of the trail car as a loading platform. Passengers boarding the trailer pay their fare as they go past the fare-box to the front end of the car, or if they go to the rear of the car, they do not pay their fare until leaving the car. In this manner about half of each load pays fare on the pay-enter plan and the other half on the pay-leave plan. This method has proved very satisfactory, and little confusion resulted from the change in method, even when first put into effect.

We did experience a great deal of trouble for a time on account of the slowness of trains in getting over the line when mixed with single cars. It developed, however, that the slowness of operation was due rather to the inexperience of the platform men than to the number of passengers carried on the trains, and, after six months' operation, we find that the amount of time necessary to operate a train over a given line is but little more than the amount required for a single car on the same line. The difference is so small in comparison to the amount of money saved in equipment and in the number of trainmen worked as to be negligible. In making up our schedules we arrange all runs so that both motormen and conductors can act as conductors on trailers during the rush hours. This, of course, requires fewer men to operate our schedules with any given number of cars than would be required if each car must be operated by two men. We find, also, that our runs can be arranged to better advantage by this method.

The train signal system between conductors and motormen is giving us some little trouble, trains being delayed for signals and slow in getting away from stops. Under our rules, even though a motorman receives his bell signal from the conductor, he should not start his car until he receives the signal light in the vestibule, indicating that all doors on the train are closed. Our present equipment being overtaxed in the rush hours, it often happens that passengers, attempting to crowd their way into cars already filled, stand in the doorways and prevent doors from closing. The conductor, busy at the fare-box, is unable to get to the door to get the passengers off the step. So it has been necessary to station inspectors at some points to clear the steps so that doors may be closed and the train properly started. We believe that this trouble would entirely disappear if we were operating sufficient cars to take care of the traffic and to prevent passengers from gathering in such large numbers.

The distribution of equipment, ever important, is especially vital to the success of trailer operation. We have not yet been able to work this out to the best advantage because of the mixing of single cars with trains, already referred to, but are hopeful that with the second hundred trailers a better adjustment can be made.

Little trouble has been given us at switches on account of operating trailers. Some motormen in their endeavor to keep their trains on time accelerate their motors too quickly when passing over switches, not waiting until the rear truck of the trailer has cleared the switch before they attain the maximum speed of their motors.

The operation of trailers in connection with peak-load city service depends entirely upon the peculiar local condition of the particular city service to which the trailer is to be adapted, and I have thought best to give you merely our experience without attempting the broad application of that experience. But I would say this much—as a personal opinion—I feel that the trail car is suitable only for peak loads, and they must be real peaks. A four-minute headway is the minimum which I consider warrants trailer operation.

AMERICAN SOCIETY OF CIVIL ENGINEERS' CONVENTION AT OTTAWA.

Preliminary arrangements have been made for the forty-fifth annual convention of the American Society of Civil Engineers at Ottawa, Ont., June 17th to 20th, 1913. Charles H. Rust, city engineer of Victoria, B.C., is chairman of the Committee of Arrangements of the Board of Direction. Charles Warren Hunt, secretary of the American Society of Civil Engineers, and Henry W. Hodge are the other members of this committee.

The following are members of the local committee:—

Charles H. Keefer, chairman; S. J. Chapleau, C. R. F. Coutlee, A. A. Dufresne, G. H. Duggan, Sir Sandford Fleming, H. Holgate, J. A. Jamieson, Phelps Johnson, T. C. Keefer, C. H. Mitchell, W. F. Tye, G. W. Volckman.

Most of the members who expect to attend the convention will be in Ottawa by Tuesday morning, June 17th, and in the afternoon will be tendered a reception by the Ottawa city officials. In the evening there will be an informal reception, with dancing, so that members of the party can become acquainted. At ten o'clock Wednesday morning, June 18th, the president will deliver the annual address, at the termination of which the business meeting will convene.

The local committee is arranging for various meetings and excursions. It is expected that there will be two evening lantern slide lectures, descriptive of engineering work in Canada; several excursions to points of local interest; a garden party; golfing at the Royal Ottawa Golf Club links, etc. A reception will be tendered by the Canadian Society of Civil Engineers to the visiting members of the American Society.

The entire programme is subject to change, excepting the time for the president's address and the business meeting. The headquarters of the convention will be the Chateau Laurier.

The expenditure on the harbor and railways in the South African Union for the ensuing year is estimated at £13,774,550, which is an increase of nearly £300,000 on the previous year. This is exclusive of capital expenditure in respect of the construction of new railways.

COAST TO COAST.

Ottawa, Ont.—Hon. J. D. Hazen has given notice of a government bill providing for a federal loan of $3,500,000 to the Quebec Harbor Commission to enable the commission to construct such terminal facilities as are necessary to properly equip the port of Quebec. The money is to be advanced from time to time as needed. The bill contains provisions similar to those in the act passed some years ago in regard to the Montreal Harbor Commission.

Vancouver, B.C.—At Nanaimo on March 4, at the opening session of the western branch of the Canadian Mining Institute the secretary drew attention to the better position British Columbia had reached in regard to loss of life in its coal mines. For the ten-year period, 1903-1912, the death rate was 5.08 killed per thousand employed, while for the five-year period, 1908-12, it will be found to have been 4.34 per thousand employed. Credit should be given, in justice to the provincial department of mines, the officials of which, during recent years particularly, have done their utmost to ensure the safety of coal mine employees.

Montreal, Que.—The announcement was made recently in London, England, of what is thought may prove an epoch-making invention in the steel trade. It is alleged that a process has been discovered for converting iron ore of any grade (even sands, of which hundreds of millions of tons exist ready for working) into steel of excellent quality without the aid of a blast furnace, the steel being produced direct, in a single operation. Tests have already been made of the steels so produced at an experimental plant and the results obtained are remarkable. No blast furnace is required, and no coke, which means an initial saving of capital expenditure as well as economy in production, while ores can be used which, at the present time, have no market value whatever. The ore is reduced by heat obtained from a gas, which is produced from slag. It is claimed that steel can be made at one-third of its present cost.

St. John, N.B.—Negotiations are now going on for the construction of the final 225 miles of the Canada and Gulf Terminal Railway connecting the present terminus at Matane with the Basin of Gaspe. The projected line runs through the very centre of the Gaspe Peninsula, about which very little was known up to a few years ago, yet the announcement is now made that complete surveys and locations have been made along the entire route, and that construction will probably be begun during the coming summer and continued for two or three years, as it will probably take that length of time to bring the rails down to the big government wharf now being constructed at Gaspe Basin, where there is at least forty feet of water at low tide. The federal government have subsidized this enterprise at the rate of $3,200 per mile, and this sum will be doubled if the cost of the railway reaches a certain sum. On the other hand, the Quebec government have granted a subsidy of three thousand acres per mile for the entire 225 miles.

Montreal, Que.—Montreal electrical engineers have become interested in Mr. Denys L. Selby Bigge, the English electrical expert, who is promoting direct current transmission of electric energy for long distances. Some of the advantages of his system are as follows: Long distance transmission of electricity in bulk with ground return to distances of 400 to 500 miles. The electrification of railroads, owing to the low cost of transmission, and feeders for the line, which in conjunction with a new form of high tension direct current traction motors and trolley line, would greatly reduce the construction and operative costs. The ease with which pulp mill or other industries in which direct current motors of high power are used, could be driven from the initial generating source, directly in series with the line, without any transformation either up or down—thus effecting great simplicity and efficiency in operation. The direct current system is not altogether new to Europe. The system has been in operation for four and a half years from Moutiers, in Switzerland, to Lyons. It was found possible to extend the system considerably, and has been linked up with water powers at Bredoire and Roselle.

Ottawa, Ont.—During the past few weeks the Canadian Northern Railway Company has been pressing the government to come to its assistance in a generous manner and assist the company to meet pressing financial obligations in connection with the completion of its transcontinental line. Sir William Mackenzie is now in Europe in connection with a general financial re-organization scheme, on behalf of the Mackenzie and Mann railway and allied enterprises. It is understood that the world-wide financial stringency has had a serious effect on the efforts to float new loans to keep all their gigantic and inter-related interests from suffering through the lack of ready money. The appeal for federal assistance has been pending for some time, but government action has so far been delayed by the exigencies of the naval issue. It is understood that the measure of assistance sought involves some twenty-five million dollars, partly by way of direct subsidies for the company's lines not hitherto subsidized from the federal treasury, and partly by way of a loan on the security of the company's railway lines. The details of the legislation have not yet been finally worked out, but it is understood that a general basis of agreement has been reached between the government and Sir William Mackenzie and Sir Donald Mann. The railway company claims that, in view of the magnitude of its undertaking, it is entitled to federal assistance proportionate to that given to the C.P.R. and the Grand Trunk Pacific.

PERSONAL.

MILLIS M. FERGUSON, graduate of Queen's University in '04, has resigned his position of city engineer of Guelph, Ont.

MR. HOLLAND, assistant city engineer of Guelph, Ont., has been appointed temporary city engineer in place of Millis Ferguson, resigned.

GEO. T. CLARK, B.A., graduate of Toronto University in Civil Engineering, of class '06, has resigned his position as city engineer of Saskatoon.

MR. R. H. THOMSON, late city engineer of Seattle, Wash., now engineer in charge of Strathcona Park for the province of British Columbia, and Mr. C. H. Rust, city engineer of Victoria, B.C., have been requested by the provincial government to report upon the proposed sewage scheme for greater Vancouver, which has recently been submitted to the various municipalities interested by Mr. R. S. Lea, of Montreal. The government have agreed to guarantee the interest upon bonds to the extent of five million dollars, this being the amount that Mr. Lea recommends should be expended at once. The remaining five million dollars to be spread over a period of some years.

MR. B. RAYMOND PHILBRICK has been appointed head of the buildings branch of the Department of Public Works, Saskatchewan, taking the place of Mr. W. P. Coltman, who has resigned by letter from England. Mr. Philbrick has been in the employment of this government for the past three years, and is a surveyor who commenced his

career in Cape Town. He took part in the Jamieson raid, and after a term in the Matabeleland Mounted Police, resumed the practice of his profession in England. With his father Mr. Philbrick became a large contractor for several public works, prior to coming to Alberta. He has until recently been supervising the work of constructing the hospital for the insane at Battleford.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a meeting of the Vancouver Branch of the Canadian Society of Civil Engineers held recently, Mr. A. D. Creer, chief assistant to Mr. Horace Lea, the consulting engineer of the Burrard Peninsula Sewage Disposal Commission, outlined the work which it is hoped to undertake in order to efficiently dispose of the sewage of the Burrard Peninsula area. There are five drainage areas, Mr. Creer stated. namely, the Fraser River, False Creek, English Bay, Burrard Inlet and Burnaby Lake. The total area to be taken care of is 52,000 acres. Mr. Creer read passages from the report of the consulting engineer showing the way in which sewage effects the waters into which it is emptied and the plans which the commission have adopted as being able to cope with the problem.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Meeting of the Toronto Section will be held at the Engineers' Club, 96 King St. West, at 8 p.m., Friday, March 28th. Secretary, H. I. Case, 709 Continental Life Bldg., Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubec, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, April 10, 1913 Contents of this issue on page 563

The Canadian Engineer

An Engineering Weekly

CALCULATIONS FOR THE STABILITY AND DISPLACEMENT OF GRAVING DOCKS

By LEONARD GODDAY, C. E. and M. E.
Late of the British Admiralty.

In dock construction there are several important points to be carefully taken into account and calculated in determining the section of the walls and bottom, viz., the pressure of the ground according to its composition or water, as the case may be, against the walls, and also the upward pressure of water against the bottom.

There is also the displacement of the dock itself, which is most essential to take into account when the sub-soil is saturated. This is nearly always the case when a dock is constructed at the entrance of a river, because the land is generally swampy and consequently filled up to the required level, and it follows that made-up ground has to be dealt with.

These methods of working were for a graving dock, carried out some years back in the old country, and the section had to be rather heavy on account of the soft nature of the ground to some depth.

The preliminary step is to decide upon the interior dimensions so that it will be large enough for the largest ship likely to be built in the future, such as length, breadth and depth.

Next, draw a section of the walls which are estimated with experience, to about the right section that will serve as a basis to start calculations, which will determine whether they can be lighter or heavier, as the case may be, and which is governed to a great extent by the displacement of the dock.

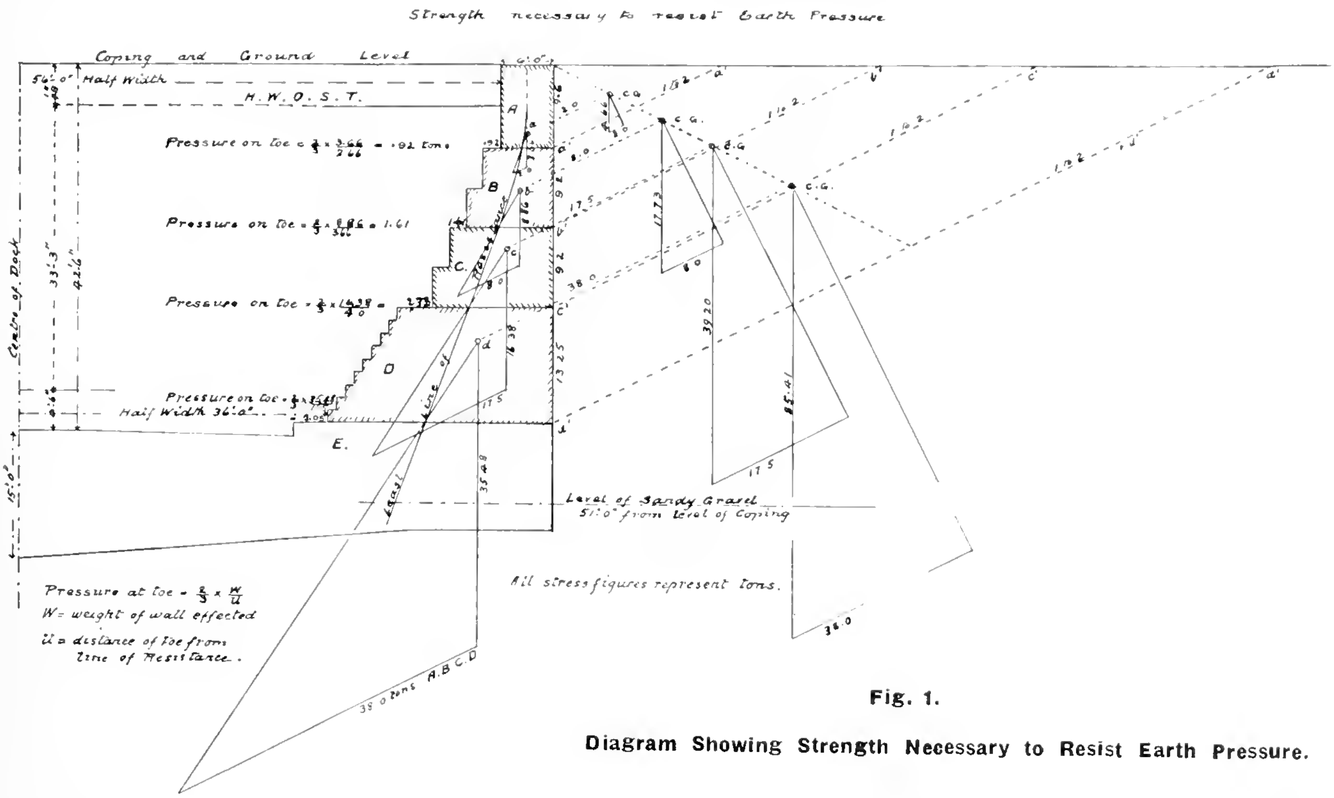


Fig. 1.

Diagram Showing Strength Necessary to Resist Earth Pressure.

Starting with the diagram (Fig. 1) for earth pressure, the wall section was divided and lettered A, B, C, D, etc., as shown. The angle of rest was taken as 2 to 1 for earth. The sections calculated are always taken as 1 ft. wide for convenience, as any length required will always be a multiple of this. The weights given are always in tons.

To begin, find the weights of A, A and B, A, B and C, and A, B, C and D, and which are 3.66; 8.86; 16.38 and

35.48 respectively. Similarly find the weights of earth prisms which are 4.66, 17.53, 39.20, and 85.41, and C.Gs of the prisms of earthwork which press against the sections of walls respectively, as mentioned, and whose angles of rest are represented by the lines a'a', b'b', c'c', and d'd'. From the C.Gs of these four prisms draw the stress diagrams, as shown, having their weights as data, and from these C.Gs draw lines parallel to the angle of rest until they cut the vertical lines drawn through the C.Gs of the wall sections. From these points of intersection construct the stress diagrams, as shown with the weights of the wall sections and earth thrusts found by the first stress diagrams as data.

Through the points of intersection of the third sides of these last stress diagrams, and the base of each wall section draw in the curve which is the least line of resistance.

representing their pressures, viz., 1.3, 4.9, 11.2 and 24.0 until they cut the vertical lines drawn through the C.Gs of the wall sections, as in the last case. From these points of intersection construct the stress diagrams, as shown, with the weights of the wall and the hydrostatic pressures as data. Through the points of intersection of the third sides of these last stress diagrams, and the base of each wall section draw in the curve which is the least line of resistance. It will be seen that the pressure per square foot on the base of each wall section, as in the case for earth pressure, leaves a good margin of safety.

The next step is to make a trial calculation for the bottom, which was drawn to a thickness of 12 feet at centre in diagram in Fig. 4, and the radius of the extrados as 14 feet, the depth at the skewbacks A and B became 8 feet.

Strength necessary to resist Water Pressure.

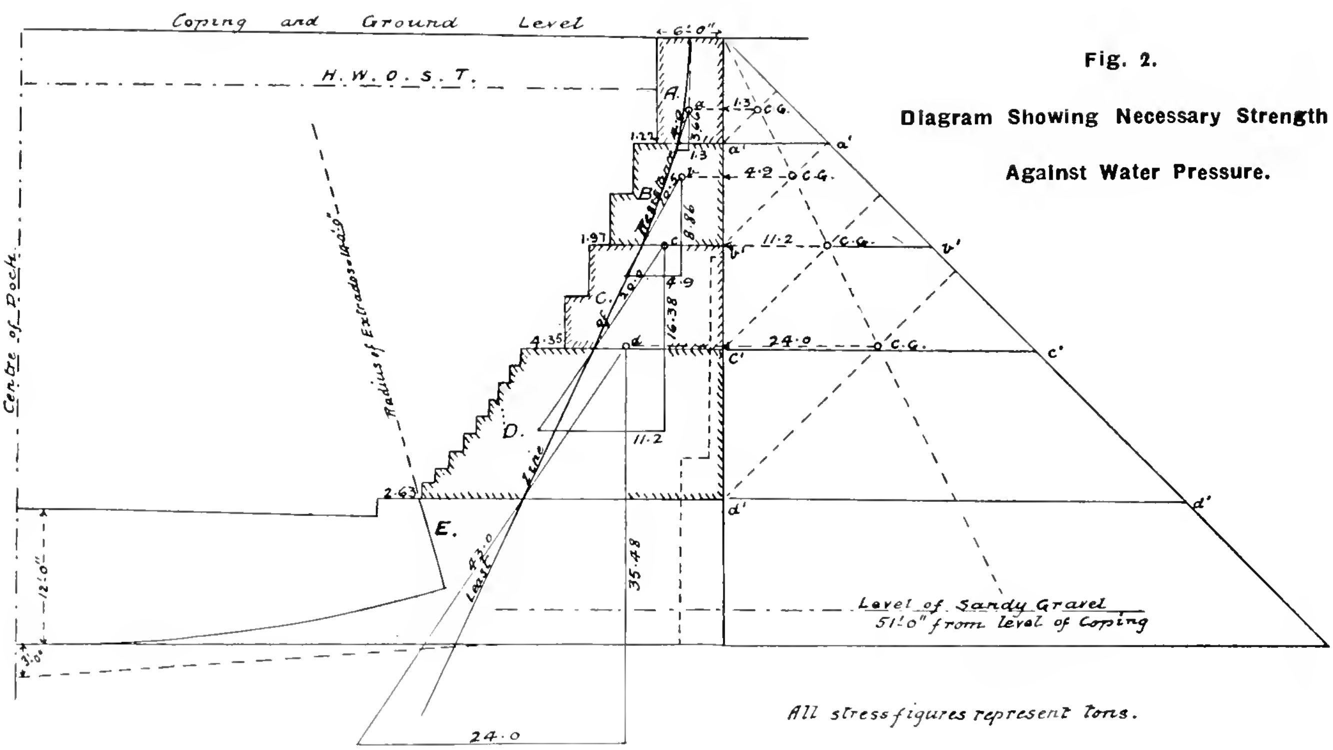


Fig. 2.

Diagram Showing Necessary Strength Against Water Pressure.

All stress figures represent Tons.

It is easily seen that the thrusts which are expressed by the third sides of the last stress diagrams divided by ⅔ the base of each wall section gives so small a pressure per square foot compared with the pressure allowed, viz., 12.0 tons, that there is every security in this case.

Lastly, find the toe pressure for one square foot at the toe of base of each section which is reckoned as ⅔ weight of the section of A, A and B, etc., divided by the distance of the least line of resistance from the toe, which calculation is shown on the diagram in each case. These pressures are seen to be well within that allowed, viz., 12 tons per square foot, and having a good margin of safety, will allow these walls to be reduced, when the calculation for displacement is being carried out.

Next draw the hydrostatic pressure for water, as in Fig. 2, as follows:—

Draw the diagram representing these pressures on the walls A, A and B, A, B and C, and A, B, C and D, as shown, their bases being a'a', b'b', c'c' and d'd' respectively, and which are subtended at coping level by an angle of 45° 00' common to all; and from their C.Gs draw the horizontal lines

Draw the horizontal line between the skewback representing the calculating span, viz., 73.5 ft. at 2.66 ft. from the top corners being ⅓ of 8 ft., and let the calculating depth at centre be from this line to a point ⅓ of 12 ft., i.e., 4 ft. from the base, and which makes it 6 ft. 6 in. The point of 4 ft. from the base is the extreme point of the middle third, and which is taken as the point for the horizontal thrust. The actual upward pressure equals the hydrostatic pressure, less the weight of the bottom, and which becomes 6¼ on each voussoir, and which acts through their C.Gs which brings the total upward distributed load of 50.0.

$$\text{Now, H} = \frac{\text{W.L.}}{\text{8.D}} = \frac{50 \times 73.5}{8 \times 6.5} = 70.7 \text{ horizontal thrust}$$

at the centre. Produce this thrust by a line α until it meets the vertical line through the C.G. of voussoir F, and from this point of intersection draw a line β parallel to the line β in the stress diagram for the dock bottom until it meets the vertical line through the C.G. of voussoir G. and continue, as shown, to the skewback, which gives a thrust of 75 feet.

The thrust at centre becomes $\frac{70.7}{12} = 5.9$ per sq. ft.

The thrust at skewback becomes $\frac{75}{8} = 9.4$ per sq. ft.

Taking the calculating d as ⅔ of thickness at centre, then thrust at centre becomes $\frac{70.7}{8} = 8.84$ per sq. ft., and

This is too small as a margin of safety.

The bottom at centre was next made 3 feet deeper, or 15 feet altogether, and then a line drawn 1 in 12, as shown, on either side until they cut the horizontal line first drawn. Also, the sides were benched in 1 ft. 3 in. and 2 ft. 6 in., as on diagram, and fresh calculations made, as per Fig. 3.

The section in Fig. 3 is practically the same as per alteration given above, and as shown in Fig. 4. The method of carrying these calculations out are similar to those in Fig. 4, with far better results for the pressures per square

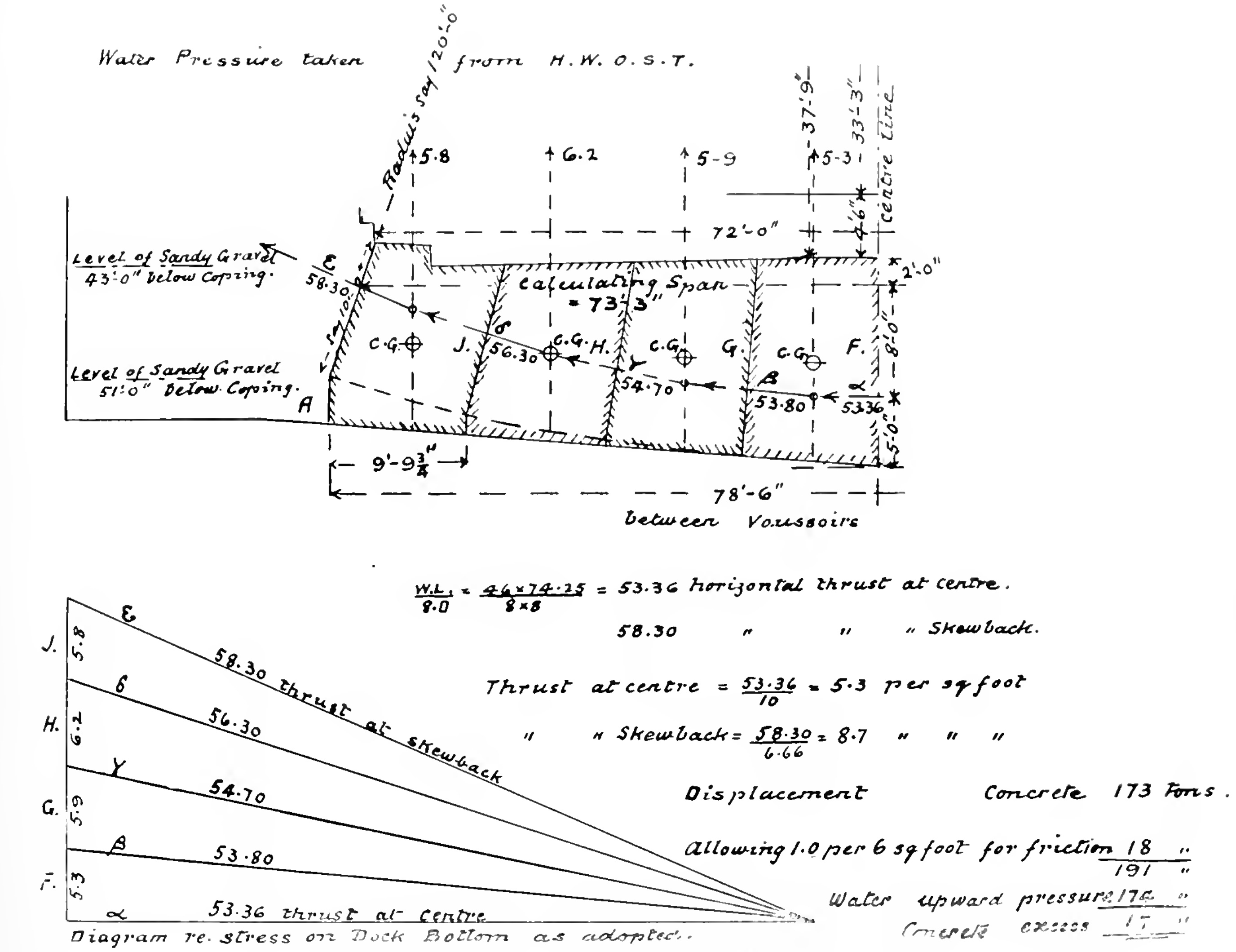


Fig. 3.—Stress Diagram of Dock Bottom; Fifteen Feet Thick at Centre.

thrust at skewback becomes $\frac{75}{5.3} = 14.0$ per sq. ft.

By the diagram for the side walls between B and C, it will be seen that the thrusts on the portions K and L of the wall become practically 75.0, and on the back of the wall 71 tons.

In respect to the upward pressure the difference between the concrete and water at section K is 0.5, and at section L is 17.5 for excess of concrete.

The total displacement is a follows:

Concrete and friction, as shown, equals	179 tons
Water, as shown, equals	174 tons
Difference equals	5 tons

foot, and in every way most satisfactory as regards displacement, which is of vital importance for the solidity and stability of the dock when completed. It may be mentioned that if a dock is too light when built in soft ground and wet, that it is liable to work upwards by hydrostatic pressure.

The construction of a dock must always be made of the very best material, and the ashlar well bonded and true in every respect, as much depends upon the workmanship.

For the purpose of affording access to the immersed parts of vessels, the ordinary graving dock, even at the present day, is the plan most commonly employed, and will continue to be preferred in places where there is a large rise and fall of tide, and where the ground is suitable for excavation.

In many parts of the world the rise and fall of the tide are sufficient to admit of a very large vessel being drawn

into a dock at high water, so as to be brought over the keel blocks, on which it then settles down as the tide recedes, and at low water the dock is left dry, and the vessel exposed for repairs, the sluices being then closed exclude the water, so that the succeeding tides cause no interruption to the work. Where the tide is but small, after the tide has receded, the water remaining in the dock has to be pumped out. This was done at the dock for which these calculations were made.

Where docks are hewn out of the solid rock and "faced" there are none of the dangers to be apprehended of settlement or of blowing up the bottom that exist where the dock is built in an excavation made in the earth, which is of an extremely treacherous character at river sides.

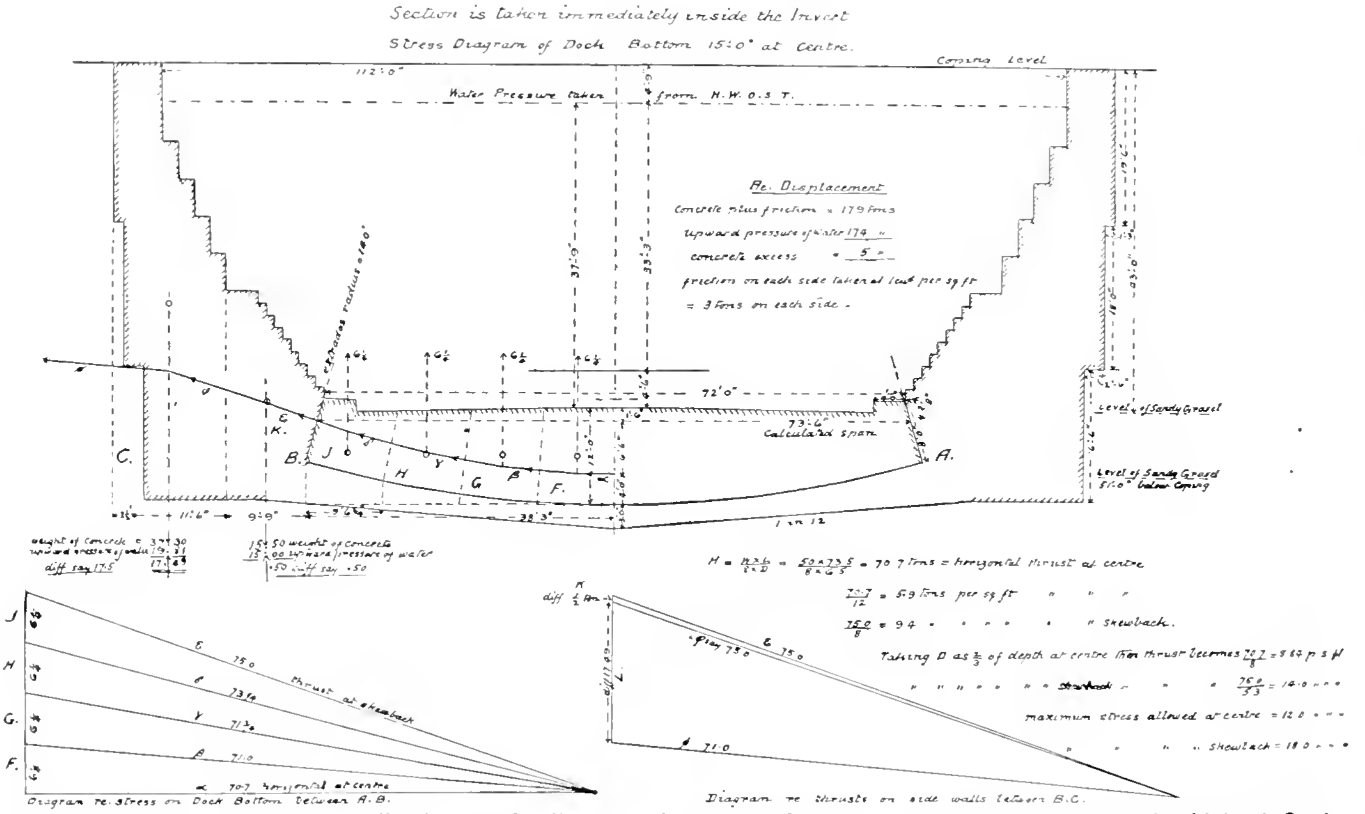


Fig. 4.—Section Taken Immediately Inside the Invert. Stress Diagram of Dock Bottom; 15 Feet Thick at Centre.

It is hoped that these calculations and remarks will be of service to those about to be engaged on work of this kind.

A NEW METHOD OF ELECTRO-PLATING.

A particularly interesting invention is that of "Voltite" by Mr. Arthur T. Firth, of New Zealand, which in brief is a method for the electro-plating of one metal on another by frictional precipitation. "The electro-plating of metals has grown rapidly to an industry of great importance," says Mr. Carl F. Woods, secretary of Arthur D. Little, Inc., of Boston, "but up to the present time there has been a great deal of economic waste owing to the practical difficulties in the way of replacing the electro-deposited metal which is lost by the friction of constant use. A number of attempts have been made to solve this problem and several patents have been issued, but in most instances the coating possible of application to the metal by this process is so thin as to be of little value.

A recent patent was issued for the deposition of nickel and other metals by friction which created considerable discussion in the electro-metallurgical world, but after a series of careful experiments it was found that the energy used in the process was so great in proportion to the results that the process possessed more theoretical than practical value.

The process invented by Mr. Firth is electrolytic like other electro-plating operations, but very much simplified and it is claimed for the invention that anyone of ordinary intelligence can operate the process successfully. The compound itself, water and the slight friction used in applying it form a voltaic action, the metallic powder forming the anode and the article on which it is to be deposited the cathode; hydrogen is developed, which reduces the salt to a metallic state upon the article itself. The operation is applicable to gold, silver, nickel, copper, tin and brass, and one of the most interesting applications is that of silver direct to steel. Perhaps the biggest field for its application lies in household use. The constant cleaning of silverware results in the removal of the deposited metal, whereas the use of "Voltite" is claimed to increase the thickness of the metal instead of decreasing it and at the same time to preserve the desired appearance of the article."

The coal production for 1912 is estimated at 550,000,000 tons by the United States Geological Survey. This amount compares with 496,221,168 tons for 1911, 392,722,635 tons for 1905, and smaller amounts for years before that. The production of anthracite shows a decrease on account of the suspension of operations during the wage controversy in April and May. There were, however, increases in almost all of the bituminous districts.

ROAD METALS.

The rapid advance of late years towards more perfect highway requirements has resulted in road metals and their study becoming an important branch of highway engineering. W. A. McLean, Provincial Engineer of Highways for Ontario, in his report to the government for the year past dealt with the subject as follows:—

Road metal, in the construction of macadam and gravel roads, serves three important purposes. It distributes the concentrated wheel load over a greater area of sub-soil; it forms a waterproof covering to protect the sub-soil from the softening effects of moisture; it forms a hard and durable wearing surface. The depth of material used, the method of placing it on the roadway, and the quality of materials used, should be proportionate to the three main factors stated. The concentrated wheel load controls largely the depth of material to be used; the necessity of having a waterproof coat emphasizes particularly the method of placing the road metal; and the need for a hard and durable covering is met principally by the quality of stone selected.

The foregoing rule is general, and while a greater depth of material makes a more waterproof surface, and will wear longer than will a thin coat; and while certain qualities of stone have better binding qualities, are more waterproof and will distribute the load at a wider angle, yet in a broad way the three requirements are responded to in the manner stated, viz., distributing power—depth of material; waterproofing—method of applying; durability under wear—quality of material.

Distributing Power—Depth of Material.—When a wagon carries in all two tons, it is apparent that each wheel places on the roadway, along a line which is the width of the wagon tire, a load of 1,000 pounds; if the wagon and its load weigh four tons, the concentrated load on a line the width of the wagon tire is 2,000 pounds. This may be assumed to be communicated to the roadway through a single cube of stone two inches square.

Experience shows that from this cube on a well consolidated roadway, the weight is distributed at an angle of about 45 degrees; and it may be shown that the area of subsoil over which the load is distributed, is equal to a square the side of which is twice the depth of the stone.

The supporting power of soil may be instanced by an extract from the Ontario Standard Specifications for Concrete Bridges, in which the bearing strength of soils, under foundations, is stated as follows:—

Rock in thick beds	25 tons per square foot
Strong gravel and coarse sand, dry..	8 tons per square foot
Compact sand or film clay, dry......	4 tons per square foot
Clay, moderately dry	2 tons per square foot
Clean, dry sand, not cemented.......	2 tons per square foot
Wet clay	1 ton per square foot
Quicksand and wet, yielding soils	0 to ½ ton per square foot

While the foregoing may be accepted as a safe guide for the depth of stone under heavy foundations, yet underneath a roadway, in which the protection from moisture is always insecure, safe loads under the macadam should not, with a proper factor of safety, be taken as exceeding one-half the amount stated.

From this analysis of the case, the importance of thoroughly draining the sub-soil becomes apparent; particularly with a view to securing the greatest possible strength of soil at the time of greatest danger, which is during the spring thaws and freshets. It becomes apparent also why four inches of stone placed on a strong, dry, gravel sub-soil may be as effective and durable as 12 inches of stone placed over a wet, slippery and poorly drained clay; and why a Telford or other strong foundation is at times essential over such a clay, and over a soft and marshy sub-soil. It explains why, in a given mile of road, the depth of stone and character of foundation may be varied half a dozen times to secure a roadway of uniform strength throughout the entire length.

Waterproofing—Method of Placing Stone.—A waterproof covering is one of the important features of a good macadam road, and this is largely obtained by the method of placing the stone. This requires a certain depth of material, not less than four inches on the strongest sub-soil, sufficient bonding material, which in waterbound macadam should be stone screenings; thorough consolidation by rolling, and a proper camber to shed water to the side gutters or drains

The depth of metal must in the first instance be proportioned to the strength of sub-soil and the concentrated wheel load, but a minimum depth of four inches is essential as that is the least depth that can be properly bonded by rolling.

Loose broken stone has about 50 per cent. of voids. If laid loosely on the road, without rolling and bonding, it will not shed water; but is merely a sieve through which rain and melting snow pass. The sub-soil is at once softened by moisture, and into this mud, the broken stone is forced by traffic, rutting the road and wasting the stone. To prevent this condition, sufficient fine material should be used on the road to fill the voids for some depth from the surface, and then rolled to thoroughly bond the stone, leaving a smooth water-tight surface from which rain is at once shed to the gutters.

Rolling takes an important place in making a water-tight surface. If not rolled, much damage to the road results before the metal becomes bonded by traffic, a considerable amount of the loose stone is driven into the mud and is largely wasted. Many gravel and stone roads in Ontario have had two or three feet of metal placed on them and forced into the mud in this way. With the voids filled with earth, the stone is of little use other than to strengthen the foundation in an inferior way. Economical construction requires a road crust of well-bonded stone laid in a well defined and uniform layer.

The camber of the road surface should be in keeping with the quality of the stone, and methods of construction. An average crown of one inch to the foot from side to centre is often specified, and this applies to the class of road ordinarily built in Ontario. This will provide for some settlement after construction. Except in the most expensive type of construction a new road should be given a crown that is too high, otherwise it will soon become too flat under traffic. It follows that in maintenance, the surface should be kept smooth and free from ruts and wheel-tracks in order that the flow of water from the surface will be immediate, and that none will have time to soak into the road.

Broken stone should be separated into grades according to size, the coarser stone to be placed in the bottom of the road and the finer at the top. This grading of stone is done by means of a rotary screen attached to the crusher. If the stone is placed in the road without being graded in this manner, the smaller stones wear away more rapidly than the larger and a rough surface results. Large stones at the surface, moreover, are more apt to become loose, to roll under the horses' feet or the wheels.

For common country roads using limestone, there should be placed in the roadbed:

(a) In the bottom a layer of stones such as are refused by a 2½-inch or 3-inch ring—"tailings."

(b) On this a coating of stones such as will pass through a 2½-inch or 3-inch ring.

(c) On this a sprinkling of screenings—that is, the dust and chips created by crushing, and including all that passes a 1-inch screen.

Course (c) should be only a thin covering, not more than enough to bond the stone when rolled. The main body of the road should be made of the grade (b).

Durability Under Wear—Quality of Stone.—The important properties of a good stone for roadmaking are (1) hardness, (2) toughness, (3) cementing properties, (4) and resistance to atmospheric action, including low absorptive qualities.

A stone may be very hard, and yet very brittle, so that toughness as well as hardness is necessary. A stone the dust of which will cement strongly, and re-cement when broken, makes a smoother and more waterproof road, and one which will distribute a concentrated wheel load at a wider angle. For this reason limestone, because of its cementing properties, is less inferior road metal than its softness would indicate. And some rocks, when first quarried, are hard and tough, yet through atmospheric action, decay rapidly. Rocks which absorb a large percentage of moisture are generally acted upon in this way by the combined action of moisture and frost. Low absorption is therefore desirable; and this is generally indicated by the weight of the stone, the heavier stone being more desirable in this respect.

The quality of stone is not a matter of name, as varieties of the same kind and even from the same quarry may differ greatly. Those who are familiar with limestone quarries know the great variation in hardness and toughness, between adjacent strata.

All things considered, the relative desirability of rocks available in Ontario for roadmaking may be placed in about the following order: (1) Trap; (2) Syenite; (3) Granite; (4) Limestone; (5) Schist; (6) Gneiss; (7) Quartzite; (8) Sandstone; (9) Slate; (10) Mica Schist; (11) Marble.

The name "trap," is one of very general application, and is usually applied to the black and green stones which, found in the fields, are known as "nigger-heads" and "hardheads." For some years, this material has been quarried at Georgian Bay, and shipped to cities in the United States. In older Ontario, the most convenient point at which it occurs is near Havelock, in Peterborough County, on the C.P.R. While trap is a most durable stone, yet consideration of economy and first cost will generally dictate the use of a softer and less durable stone of the locality in which the road is being built.

Throughout Western Ontario, limestone is common, and the greater mileage of roads is now being constructed of that material, since quarries are within easy access of almost any part of the province. Limestone ranges in quality from that which is very soft and decays rapidly, to that which is very tough, with strong cementing properties. If tough and close-grained, it is an excellent material for roads on which the amount of traffic is not excessive. In some parts of Eastern Ontario, granite, gneiss and schist are being used, and are proving very suitable. Granite is a harder and tougher stone than limestone, but its cementing properties are inferior; and a good practice when granite is employed, is to use limestone screenings to surface and bond the road.

Field stones are frequently used. Picked up from the fields, they are usually found to consist of fragments of trap, granite, gneiss, limestone, sandstone, and other varieties Owing to lack of uniformity, the serious deficiency of this material is that the softer stones wear more rapidly than the others, and in consequence a rougher surface is ultimately produced under traffic. Field stone, however, forms a good source of supply for road metal, and if obtainable in the locality, should generally be used in preference to stone shipped by rail.

Reliable tests of roadmaking material have been devised, relating to crushing strength, degree of toughness, degree of hardness, cementing properties; and absorption, indicated by weight or specific gravity. No test is so conclusive, however, as actual wear on the road, and old roads in the locality may be instructive.

Simple tests may also be applied. We may judge of the qualities of a stone by breaking with a hammer, wearing on a grindstone, crushing it in a blacksmith's vice, scratching with an iron nail, breaking small pieces with the fingers. A heavy stone is usually better than one that is light. A stone that breaks into cubical shapes is desirable, whilst one that breaks into thin, flat shapes is objectionable.

As previously suggested, the stone of the locality in which the road is being constructed should generally be used. Freight rates and additional cost of handling, will often add 50 per cent. to the cost of a road, as compared to the cost of a road made of stone obtained in the vicinity. It is usually better to accept an inferior stone, and resurface more frequently, than to pay freight rates on a more durable stone shipped in from a distance. This, however, will depend somewhat on traffic, and where travel is extremely heavy or constant, it may be in the interest of economy to pay freight rates for the more durable material. At times it is good practice to use soft material of the locality for the foundation of the road, and surface it with a tougher and more durable material, placing about 4 inches of the latter material on the surface.

SIDEWALK CONSTRUCTION POINTERS.

When it is proposed to lay a cement walk on a foundation that has been travelled over for several months, the entire surface should be loosened up, flooded, and thoroughly tamped down. This is common-sense, for, on a sub-base of this character, the foot travel generally follows one well-defined line, usually in the centre, which becomes solid and well packed and will not settle under additional weight; while the filling to either side of the centre, on being given additional weight, usually settles sufficiently to cause a crack lengthwise through the walk, unless the entire surface is first loosened and retamped to a uniform density.

A successful contractor states that in cold weather he mixes the concrete as dry as it is possible to have it, and then puts in the base in two courses, tamping each course separately—in this way obtaining a more uniform density in the concrete; and as a result he has never had to record a failure in his work. Better results will be obtained, and fewer walks with loose and cracked wearing surfaces would be seen, if workmen could be made to understand that a wearing surface will not adhere to, or form a bond with a base covered with loam or dirt which they have tracked over it either through carelessness or in order to save a few steps.

Clean-cut joints between slabs, and expansion joints adjoining the curbs at streets and alley returns and at frequent intervals in long stretches of walk, are absolutely necessary if broken curb-stones and broken slabs in the walks are to be avoided. Expansion joints at street and alley returns can be eliminated by constructing the curbing with a recess into which the sidewalk slab may be laid.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz, M.E.

(Continued from page 521 of last week's issue).

A number of investigations have been made to determine the effect of electrolysis on iron or steel embedded in concrete, and these have shown that where the iron is an anode —that is, where current passes from the iron to the concrete —this effect is to corrode the iron and form rust which occupies more space than the iron, causing expansion which finally cracks the concrete. The most recent and most complete investigation of this kind is one made at the Bureau of Standards, Washington, and described in a paper by E. B. Rosa, Burton McCollum and O. S. Peters, presented before the National Association of Cement Users in Pittsburgh, December, 1912. These recent experiments have shown that an extremely small current, flowing from an iron rod to a surrounding block of concrete, will produce enough corrosion to crack the concrete in the course of one or two years. These investigations have also shown that the presence of even a fraction of 1 per cent. of salt or of other chlorides may increase the action of electrolysis on iron embedded in concrete over 100 fold. They have also shown that, where the iron is a cathode—that is, where current passes from concrete to the iron—a softening of the concrete is produced in the immediate neighborhood of the iron which eventually destroys the bond between the concrete and the iron. The introduction in recent years, of buildings constructed entirely of reinforced concrete, has raised the question of the possible damage to such buildings from electrolysis of the reinforcing steel. Where reinforced concrete structures are located near railway power stations which have a grounded negative bus-bar, there may be a considerable potential

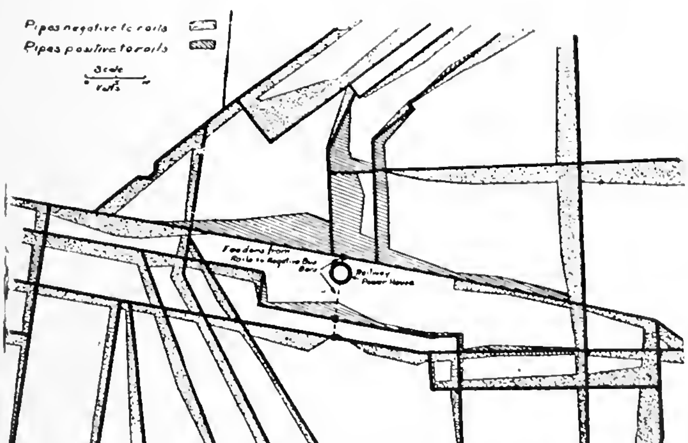


Fig. 3.—Typical Potential Survey of City, Showing Electric Railway Tracks and Potentials of Underground Pipes to Trolley Rails.

gradient through the ground upon which the concrete building stands, and in such cases it is possible that currents may flow through such a reinforced concrete building. These currents, although very small in magnitude, may cause a great deal of damage because the successive elements of steel and concrete form a series circuit, and damage will result at every point where current flows from steel to concrete or from concrete to steel. The most likely means of entrance or exit of stray electric currents, into or out of such buildings, is by underground gas or water pipes, or by foundations of concrete or of steel. In the light of these recent investigations it would, therefore, seem a wise precaution in such buildings to install insulating joints in every pipe which connects to the building from ground. In the paper above referred to it is also suggested that granite blocks might be interposed between the building footings and soil so as to prevent stray currents from flowing into and out of the building through the footings.

Electrolysis Surveys.—The diagram illustrated in Fig. 2 shows that voltage drop in the rail produces stray current through ground and through underground pipes, and pro-

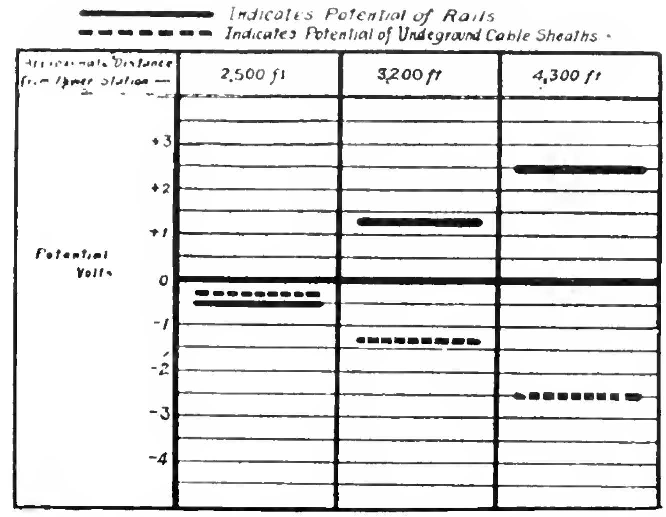


Fig. 4.—Diagram Showing Route of Potentials with Pipes Taken as the Datum or Zero Potential.

duces potential differences between pipe and rails, making the pipe appear positive in potential where current leaves the pipe, and negative in potential where current flows to the pipe. The first step in an electrolysis survey of a town is, therefore, to measure potential differences between pipes and rails, at a number of points throughout every street on which there are electric railways. Where the main itself is not exposed, connections to the pipes for these voltmeter measurements may be obtained by means of service pipe or drip connections. Such connections are generally satisfactory because the voltmeter itself has a high resistance and, therefore, takes only a very small current. Readings are taken at each point every 10 seconds for 10 or 20 minutes, depending upon the car schedules, and the maximum, minimum and average results of the readings recorded. A convenient instrument for these potential readings, which can also be used for the drop measurements described below, is a Weston, Model 1, combination millivoltmeter and voltmeter, with its zero in the centre of the scale, and having ranges of 5, 50 and 500 millivolts and of 5 and 50 volts. These instruments are made with very high resistances, so as to be particularly applicable to electrolysis testing.

After such potential measurements have been made throughout the principal streets of a town, they are then conveniently plotted on a skeleton map of the town, in which the trolley lines are shown. The potentials of the pipes referred to the rails are laid off normal to the lines representing the railway tracks to some convenient scale, usually 1 inch = 10 volts. The ends of these potential lines are then connected, and the included areas are colored red where the pipes are positive in potential to the rails, and blue where the pipes are negative in potential. In Fig. 3 is shown a typical potential survey map, in which the negative areas are

shown by dots, and the positive areas by section lines, instead of by blue and red areas. It will be noted that, in the neighborhood of the railway power station, the pipes are highly positive to the rails, and at points distant from this station they are negative to the rails. The existence of potential differences between pipes and rails is, however, no conclusive evidence of stray currents on the pipes; they indicate at what points current is probably flowing from rails to pipes and from pipes to rails.

Where there are a number of underground metallic structures which may be affected by electrolysis, it is desirable to make simultaneous measurements of potential difference between the rails and each of these structures. The average values of these simultaneous potential measurements may then be conveniently plotted on a diagram in which the

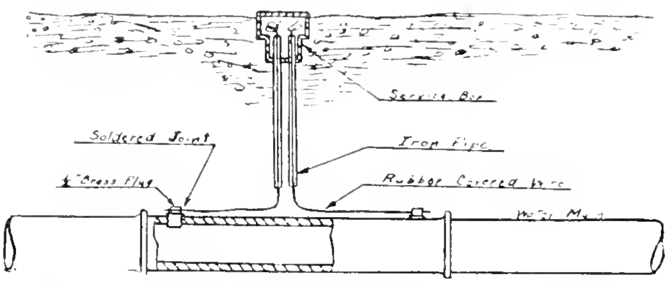


Fig. 5.—Permanent Electrical Test Wire from Surface of Street to Pipe.

potential of any one of the structures is taken as the datum or zero of potential. In Fig. 4 is shown a set of diagrams giving the relative potentials between water pipes, trolley rails and underground cable sheaths, at 3 points along a given street. In this diagram the water pipes are assumed as the datum or zero of potential, and the potentials which are positive to the pipes are laid off above the axis, while those which are negative to the pipes are laid off below the axis, to the scale indicated in the diagram. In the case shown in Fig. 4, the cable sheaths are connected to the railway return conductors near the railway power station. It will be noted that, at the point nearest the power station, the water pipes are positive both to the cable sheaths and to the rails, and that the cable sheaths are also slightly positive to the rails. At greater distances from the power station the rails become increasingly positive to the water pipes, while the cable sheaths become increasingly negative to the pipes. The potential difference between the rails and the cable sheaths increases very rapidly with increasing distance from the power station, as is seen from Fig. 4.

The next step in the survey is to measure drop between drip or service connections, which will indicate the probable existence and direction of current flow on the pipes. Such drop measurements cannot, however, be used for calculating the amount of current on the pipes. To determine the actual current flowing it is necessary to measure the drop between two points on a continuous length of pipe by means of a millivoltmeter. This drop, expressed in volts, divided by the assumed or measured resistance in ohms of the included length of pipe, gives the current expressed in amperes. A convenient table giving the current in amperes for 1 millivolt drop in 1 foot of standard wrought iron, steel and cast iron pipes is appended to this paper. To find the current flowing on a pipe corresponding to a given drop in millivolts for a measured length, multiply the amperes given in the table for 1 millivolt drop for 1 foot by the number of millivolts drop measured, and divide by the included length of pipe in feet. To measure this drop it is necessary to expose the pipe and to make good electrical contact between the millivoltmeter leads and the pipe. A satisfactory method is to use a pointed piece of steel, about the size of an ordinary lead pencil, fastened in a wooden handle, with a flexible connecting wire soldered to it inside of the latter. The pointed steel is then pressed against a bright spot or into a filled notch on the pipe. A still better contact is obtained by soldering the connecting wire directly to the pipe or to a brass plug screwed into the pipe, which is particularly advantageous when readings are to be taken over a considerable time. When such contact wires have been soldered to a continuous length of pipe it is common to use rubber covered wires, bringing them to the surface of the street, leaving the ends in drip or service boxes, which then form permanent test stations for electrical measurements. This is exceedingly convenient, for it is then possible to make current measurements on the pipe without again digging an excavation. Such permanent contact wires for electrical tests are illustrated in Fig. 5.

It should be noted that small potential differences, such as 0.1 millivolt or less, may be caused by local galvanic or thermal action. Where such small values are found in a test for drop on a pipe a careful investigation should, therefore, be made to ascertain whether the observed potential difference is actually drop due to current flow or is due to local causes. The writer has found that such local potential differences are a frequent source of error when such tests are made by persons who are not accustomed to making accurate electrical measurements.

When drop measurements between services and current measurements on pipes have been generally made on a piping system, the results are conveniently plotted on a skeleton

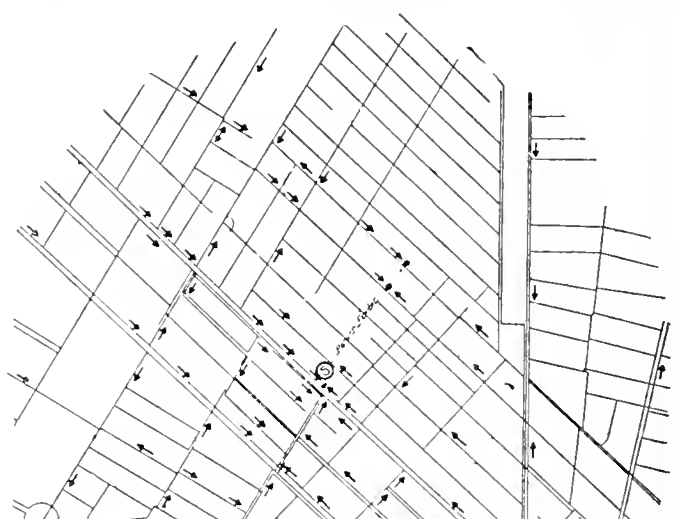


Fig. 6.—Typical Current Survey, Showing Underground Mains and Stray Currents Flowing on Mains.

map of the city in which the pipe lines are shown and the current flowing on these pipes are indicated by arrows. A typical current survey map of a portion of a city is shown in Fig. 6. It is seen that here the currents on the pipes flow in a general direction towards the railway substation.

Since current destroys the pipe only where it leaves the pipe for soil, it is important to know where the current does

leave the pipe. Current measurements on pipes are, therefore, frequently made at two or more stations simultaneously in order to determine the change of current on the pipe between the stations. In Fig. 7 simultaneous current measurements made at two stations on a pipe are shown plotted where there is no change of current between the stations. In Fig. 8 simultaneous current measurements at two stations on a pipe where there is a considerable loss of current between the stations are likewise shown.

In order to determine the characteristic variations of a potential difference between pipe and rails, or of current flow on a pipe, 24-hour records of such potential difference, (or of current flow) may be obtained by means of a special Bristol, smoked-chart, recording instrument. This recorder has for its measuring system a sensitive Western millivoltmeter, and may be provided with a number of ranges. It is convenient to have the instrument provided with its zero in the centre of the scale, and with ranges of 5, 50 and 500 millivolts, and of 5 and 50 volts. Shunts of any desired ampere range can also be used in connection with the recording millivoltmeter, and the instrument used as a recording ammeter of a corresponding range. Convenient shunts for this are ordinary switchboard shunts adjusted for 50 millivolts drop, with rated capacities of 5, 50 and 500 amperes. Such potential and current records are conveniently plotted from these charts in rectangular co-ordinates. Sample 24-hour records of current on a pipe plotted in rectangular co-ordinates for one week are shown in Fig. 9, from which it will be seen that the current records for weekdays are practically alike, and show morning and early evening peaks. The record for Sunday is, however, very different and shows a very large peak throughout the whole afternoon. This is accounted for by the fact that the neighboring trolleys were carrying large crowds of excursionists on Sunday outings. By means of such 24-hour records it is often possible to positively identify the source of current flowing on a pipe as railway current from its similarity with the railway load curves. Twenty-four-hour records of current flowing on pipes may also be

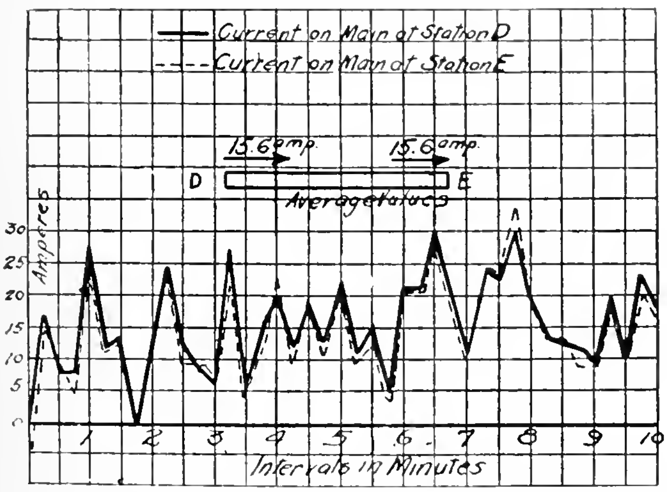


Fig. 7.—Simultaneous Current Measurements Where There is no Change in Current Between Stations.

obtained at two or more stations simultaneously, and the change of current between the stations for the 24 hours determined.

It is possible to trace the path of current flow through ground by measuring potential differences between points in the ground. Where small potential differences are measured between two points in ground and iron rods are used as electrodes, entirely incorrect results may be obtained, because of possible differences in polarization voltages at the surfaces of the electrodes. To overcome this difficulty, a "non-polarizable electrode" was devised by Prof. Haber. This consists of a glass tube, with a porous cup cemented to one end, containing a saturated solution of zinc sulphate, and of a zinc rod dipping into the solution. A wire is brought out from this zinc rod through a cork in the top of the tube. To make contact to ground with this electrode the porous cup is pressed against the part of the ground at which the potential is to be measured, thus establishing contact between the ground and the zinc sulphate solution. This establishment

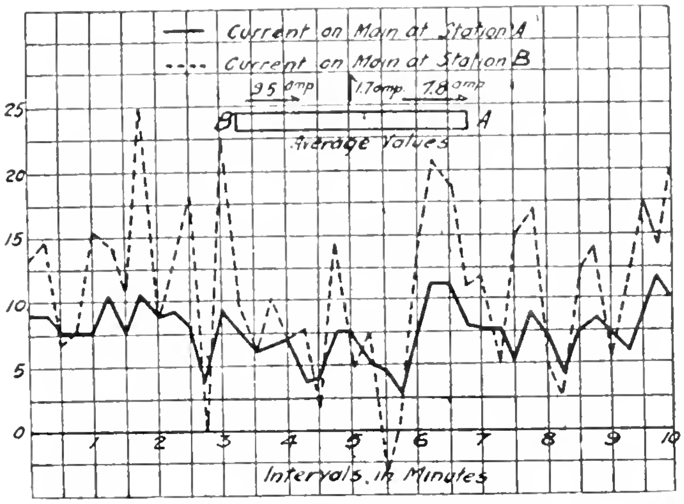


Fig. 8.—Simultaneous Current Measurements Where There is Change in Currents Between Stations.

of electrolytic contact between ground and the zinc sulphate solution eliminates polarization voltages. The polarization voltage between the zinc rod and the zinc sulphate solution, which is a definite known voltage, must be allowed for when using this electrode. It is also essential that, when this electrode is used, the potential measurements be made by means of zero methods, and not with indicating volt-meters, because of the very high contact resistance produced with this electrode.

It is often also desirable to measure directly the flow of current through ground, as between a pipe and rails, or between two pipes. This can be done by means of an earth ammeter, which was also devised by Prof. Haber. This consists of a wooden frame with two copper plates insulated from each other by a plate of mica or glass. Insulated copper wires are brought out from the two copper plates, and these wires are connected to an ammeter. To use the frame, the two copper plates are, first, coated with a paste made of copper sulphate and a 20 per cent. sulphuric acid solution. A wetted piece of parchment paper is then laid over the paste, and the remainder of the frame filled with soil from the excavation where the current flow through ground is to be measured. The frame is then buried in ground normal to the direction of the current flow to be measured, and the ammeter will indicate the current flow which is intercepted by the buried frame. The object of the copper sulphate paste on each plate is to equalize polarization potentials at the surfaces of the copper plates. This earth ammeter is also well suited for measuring current flow between pipe and ground. For this purpose the frame is buried in the ground one or two inches from and parallel to the pipe. Measurement of current flow from a pipe thus made can be used to form an estimate of the probable amount of electrolytic damage to the pipe, and in cases where corrosion has taken place,

this kind of test will often serve as evidence that the corrosion has been caused at least in part by stray currents leaving the pipe. By using a recording instrument in connection with the earth ammeter, the characteristic variations of the current leaving a pipe can also be determined, and in this way the identity of the current can often be established.

From a study of the results of the survey it can be determined where current is leaving the piping. At a number of such points excavations should then be made and the exposed pipe examined with a test hammer for electrolytic corrosion. Where such corrosion and pitting are found at points where current is found leaving the pipe, it may be taken as evidence that the destruction was caused by electrolysis, because it has been conclusively proven that current cannot leave iron for surrounding soil without producing corresponding destruction of the iron.

Regarding the use and value of an electrolysis survey, it must be remembered that the object of the survey is to indicate the existence or non-existence of stray electric currents upon a piping system, and to determine where such currents flow on to the pipes and from the pipes. I have had occasion to examine a large number of electrolysis surveys and have found that many of these consist exclusively of voltmeter readings, and often these voltmeter readings are only made with reference to the rails. Such readings by themselves do not afford a measure of electrolytic danger.

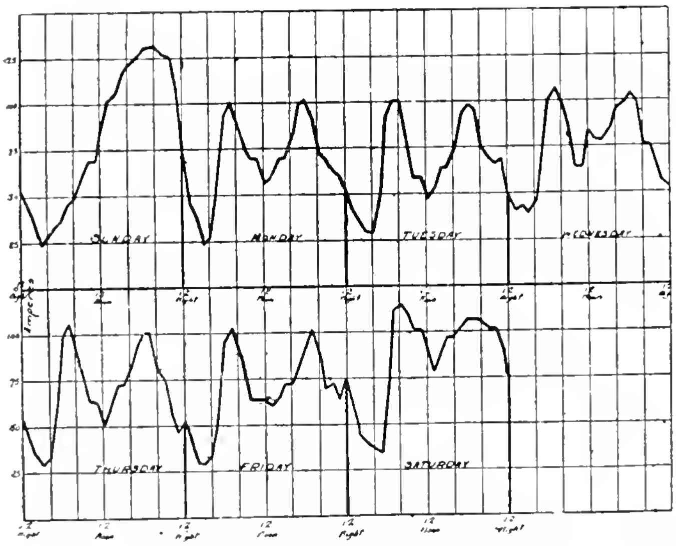


Fig. 9.—Stray Currents on Water Main Averaged from 24-Hour Record and Plotted for Week.

Potential measurements should be made to all underground structures. Measurements of current flow on pipes are also essential in an electrolysis survey because all current which flows on a pipe must leave it, and the amount of damage produced is proportional to the total current which leaves the pipe. I have seen some reports, on the other hand, where it is stated that the current on a given pipe is zero, but where the instruments and methods employed were not sufficiently sensitive to detect current as large as two or three amperes, and where, therefore, the conclusion of zero current is not warranted. From a complete and properly analyzed electrolysis survey, a great deal of good can generally be accomplished. It will not always be possible to remove all stray currents from the pipes, but measures will be indicated by which the conditions can be greatly improved, and points of greatest danger will be located. If then trouble does occur at a later time at these points, the electrolysis survey may be most valuable in affording proof of the destruction of the property from railway currents, and may be the means of compelling the railroad company not only to pay for the damage, but also to make improvements in its return system so as to avoid the recurrence of such damage. I know of a number of electric railroad companies who are regularly paying for damage caused by electrolysis to piping systems. The knowledge that a pipe-owning company is making electrolysis tests and is keeping watch on the situation, also has a strong moral effect on the electric railroads.

(To be continued).

HEMLOCK AND ITS USES.

The British Columbia Forest Service has data showing that western hemlock, which is being cut in increasing quantities on the coast, is a much more valuable timber than was heretofore thought. The sale is increasing throughout the province, some companies having placed it on the prairie market in successful competition with Douglas fir, on account of the lower freight rate and the relatively smaller danger of splitting in nailing. This latter reason makes it acceptable for joining and siding. At present the principal use of hemlock in British Columbia is in pulp manufacture, great areas in the north being cut over to supply this growing industry.

Authentic data are lacking with regard to the durability of western hemlock as compared with Douglas fir and other woods. The general impression is that Douglas fir is the more durable.

A few experiments made to determine the adaptability of western hemlock to treatment with liquid preservatives indicate that, as compared to Douglas fir, it offers about the same resistance to impregnation across the grain; but that it is easier to penetrate along the grain.

Hemlock is well suited for use in all but the heaviest construction work, as shown by results of tests which have been made, but up to the present time it has had a limited use in bridges and trestles. It has been used in some instances for caisson construction.

A considerable amount is cut into cross-ties. Many of the western railroads use Douglas fir, western larch, redwood and western hemlock exclusively for tie material. A large percentage of those ties are laid without preservative treatment. Occasionally it is cut into telephone or telegraph poles, but its use in this form has been very limited. It has the requisite strength for pole use and grows in such dimensions as to make it very suitable for this class of work. With a good treatment with some efficient preserving fluid it should give good service as a pole material.

Though practically all piling in the west is of Douglas fir, western hemlock is used to a limited extent, however, for this class of work and has apparently given satisfaction.

In house construction it is used a great deal as a framing material. For this class of work it serves as well as Douglas fir, and locally commands the same price.

When cut edge grain it makes good flooring material. It finishes smoothly on account of the uniform texture of the wood and it also wears evenly. It is not suitable for use in damp places on account of its tendency to warp under such conditions.

As a finish lumber it has the advantage of containing practically no pitch; it has a beautiful grain, works smoothly, takes stain readily, and when properly dried, will not shrink or swell materially under normal conditions. It presents a comparatively hard surface and consequently does not mar easily.

Western hemlock slabs and edgings are manufactured into lath, and as a lath material it is equally as valuable as Douglas fir or other wood. In this form there is no distinction made as to species, all pieces of a suitable form to make lath being thrown in together and used indiscriminately.

It is used to a large extent for barrels and boxes for shipping foodstuffs. For this purpose it serves admirably, since the wood is odorless and tasteless. A good development along this line may be looked for when consumers realize the value of the wood, and cease wasting it as at present.

PAINT AS AN ENGINEERING MATERIAL.*

By Dr. Maximilian Toch.

The progress that paint chemistry has made since 1905 is by far greater than the progress that has been made from its earliest invention up to that date. It is very difficult for me to imagine that my first book on "The Chemistry of Paints" stimulated others to continue the work which I had started, and if the little that I have done to enlighten the manufacturers and consumers has brought about the progressive results, I certainly have been rewarded for all the work I have ever done on the subject.

The first skyscraper ever built was the Gillender Building, corner of Wall and Nassau Streets, which was razed two years ago. Chemists knew before this building was demolished that linseed oil paint was not the best material for the protection of steel of large buildings. The question as to whether our monumental buildings are permanent has been a source of great worry to many chemists and engineers. Fortunately, if any of the steel contained in buildings like the Woolworth Building, Metropolitan Tower, the Singer Tower and dozens of others should show signs of corrosion and disintegration, the process is so slow that preventive methods could be applied, for a beam could not corrode in a masonry wall without cracking or bulging the wall. I have in mind one building in Maiden Lane where this actually occurred, and the wall of the fifteenth floor was cut away, the corroded beam exposed, thoroughly scraped, painted and reinforced, surrounded by concrete, and the brick wall replaced.

From the street level up every skyscraper in the world is safe, but from the street level to the grillage beams is the dangerous point. Of course, a small building could be "jacked up" and a grillage beam replaced. In a large building, two of which I have in mind, where the grillages were affected by leaky electrical currents, the foundation beams were uncovered, scraped clean and painted, and then a grout of almost pure neat cement injected all over the surface. Of course, it would be out of the question to "jack up" a building like the Woolworth Building or the Metropolitan Life, even though Archimides said: "Give me a fulcrum and I will move the world," but it is a source of great satisfaction to know that engineers and architects in charge of these buildings have taken sufficient precautions to prevent any danger whatever, either from electrolysis by means of stray currents, or from corrosion by means of dampness, and all the sensational talk about danger of the newer skyscrapers not lasting fifty years is utter "rot," for not one of these buildings is so constructed that should any danger result it could not be remedied in due time.

* Abstract of address before the American Chemical Society.

That paint is an engineering material of incalculable value is evidenced by the fact that none of our bridges would last ten years if they were not repeatedly painted and watched. The railroads are much wider awake to this condition than the municipal governments. Politics and paint do not mix very well, as is evidenced by the condition of some of our bridges. It may be very safely said, that all of our elevated railroads in New York City and all of the battleships of the United States government depend for their life on the frequency with which they are painted. My examination of the battleship "Maine" when the wreck was uncovered last year showed that not a vestige of paint remained, and it furthermore showed that wherever steel and copper, or iron and bronze were in close proximity an electric battery was formed and the iron was completely dissolved.

This, then, leads me to the general subject of the more modern type of paint containing no saponifiable oil, but made entirely of such materials as are unaffected by alkali, and such tremendous structures as the Pennsylvania Terminal, in New York City, the Metropolitan Life Tower, and Building, the Woolworth Building, and the newest and largest of all engineering structures—the New York and Connecting Railway not yet begun—are types of modern structures in which the old-time linseed oil paints have been superseded and protected by more scientific paints. Perhaps the most remarkable fact in all these instances is that fifteen years ago perhaps one concern in the United States started a campaign of education and convinced many prominent and well-known engineers that paint was an engineering material, and not one material is suitable for all purposes, with the result that the paint industry has been raised from empiricism to an exact science. Ten years ago nobody dreamed of painting cement floors or cement walls on account of the tradition that it was impossible to paint concrete. It is quite true that it is impossible to paint new concrete with a linseed oil paint owing to the resulting chemical action of the combination of the oil and the lime in the concrete, and yet when the first patent was taken out on this subject nobody infringed because it was believed that it could not be a success, but after it was demonstrated that this was a success it was the same story as "Columbus and the egg," and everybody iimitated and made a success of it.

The United States Navy, through one of its most efficient naval constructors, Mr. Henry Williams, has kept pace with the paint progress, and Mr. Henry Williams' article, a treatise on the subject of "Newer Paint Conditions in the United States Navy," read before the Eighth International Congress of Applied Chemistry, was copied not only by every paper in the United States, but was heralded throughout Europe, and to those who want to know what excellent progress has been made in this branch of the government, I would refer to his excellent treatise on the subject which is to be found in the transactions of the Eighth International Congress of Applied Chemistry.

Before closing my remarks and showing the illustrations I have taken for this lecture, I must say a few words regarding the sensational statements that have appeared lately in the press concerning the poisonous effects of white lead on workmen. It is very true that lead injected or absorbed in any form into the system produces plumbism, but the matter is not as serious as sensational newspaper writers have made it. All this talk about putty powder poisoning men in glass polishing factories is practically untrue, for putty powder happens to be tin oxide or a mixture of tin oxide and precipitated barium sulphate. The use of lead compounds in the preparation of wall papers is just as ridiculous as the arseni-

cal poisoning which was supposed to have injured so many operatives who used green pigments for printing wall paper designs. It turned out, of course afterwards, that the green pigments were chrome pigments, and the percentage of arsenic contained in the aniline dyes was so minute that even if they had dusted off it is a question whether they would have done any harm, for the pigments which are printed on wall paper are never released from their base.

The precautions that are taken in the white lead factories in the United States are so great that the plumbism which results is due to a large extent to the carelessness of the workmen themselves. As far as my personal experience goes, it is the hardest thing in the world for us to educate illiterate workmen that they must wash their hands before they eat, and the State is now distributing circulars printed in various languages notifying workmen that it is illegal for an employer or an employee to permit food to be consumed where these materials are manufactured. We are all well aware that the transportation of high explosives is exceedingly dangerous. There have been some frightful holocausts resulting from explosions in transit, and yet it is safe to say that any civilized country would go back untold and countless years if laws were enacted prohibiting the transportation of explosives, for coal metals and minerals would lie practically untouched in the ground; and the only safeguard is that, knowing that the materials are necessary for the excavation of the riches of the earth, due care should be taken in their transportation. Practically the same is true in the manufacture of any hazardous material, and therefore sensational and irresponsible statements pertaining to the manufacture of any chemical, whether it be lead or nitroglycerine, are to be decried.

COSTS OF CONCRETE PAVEMENT.

We publish below a table taken from the Journal of the American Society of Engineering Contractors, showing the amount, average price, and some details of concrete pavements constructed in a number of American cities:—

	Sq. yd.	Av. price per sq. yd., including grading.	Guarantee. Years.	Total thickness of pavement. Inches.	Proportions.
Portland, Me.	11,238x	$1.29	....	6	1:2½:5
Lynn, Mass.	21,402	1.70	5	6	1:2 :4
Trenton, N.J.	2,826	1.44	1	6	1:2½:5
Seymour, Ind.	1,250	.90	3	7	1:6[1]
Edwardsville, Ill.	8,950	1.40	½	7[2]	1:3 :5
Alpena, Mich.	13,000	1.30	....	8	1:6
Escanaba, Mich.	12,000	.87	0	6¾	......
Fond du Lac, Wis.	11,043x	1.25	5	6½	1:2½:5
Sheboygan, Wis.	19,860x	1.28	0	8½[5]	......
Bemidji, Minn.	19,826	.90*	2	5	1:3½
Burlington, Iowa	4,489	1.34	5	6½	1:2 :5
Cedar Rapids, Iowa	2,178	1.16*	...	7[8]	1:3 :5
Davenport, Iowa	13,208	1.23*	2	7[6]	1:3 :5
Fort Dodge, Iowa	7,900	1.60	5	7[7]	1:3 :5
Marshalltown, Iowa	14,000	1.18	0	7	1:3 :5
Mason City, Iowa	42,000	1.30	5	7[8]	1:2 :5
Sioux City, Iowa	100,000	1.20	....	5	1:3 :4½
Kansas City, Mo.	81,000	1.05	5	6	1:2½:4½
Grand Island, Neb.	3,754	1.30	....	....	......
Omaha, Neb.	4,485	....	....	....	......
South Omaha, Neb.	13,200	1.30	5	6[10]	1:2½:5
Kansas City, Kans.	...	1.09	5	6	......
Ottawa, Kans	996	1.03*	2	6	1:2 :3
Wichita, Kans.	2,137	1.00*	2	6	1:2 :4
Billings, Mont.	2,000	2.25	2	7½[11]	1:6
Boise, Idaho	23,166	1.12*	....	6	1:3 :5[12]
Grand Junction, Col.	18,000	2.20	....	7[13]	1:3 :6
Vancouver, Wash.	15,220	1.15*	....	5	......
Portland, Ore.	31,417	....	....	....	......
Salem, Ore.	85,266	1.30*	0	6	1:2 :4

* Does not include grading. x Reinforced.

[1] 1-6 mix; 1-2 surface. [2] 5 in. base, 1-3-5 mix; 2 in. top of 1 cement, 1 small gravel, 1 sand. [3] 4 in. base, 2 in. wearing surface. [4] 5 in. base, 1-2½-5; 1½ in. top, 1 cement, 1 sand, 1 gravel. [5] 6½ in. at gutter, 8½ in. at centre. [6] 5 in., 1-3-5 mix; 2 in. top 1-2. [7] 5 in base, 1-3-5; 2 in. top 1-1-1. [8] 5 in. base 1-2-5; 2 in. top 1-2. [9] 1¾ in. 2-3 grout; 5¼ in. 1-7 mix. [10] 6 in. and 8 in. [11] Laid in 6 in. gravel base; pavement; 6 in. 1-6 gravel base and 1½ in. 1-2 mortar top. [12] Also 1-3-7. [13] 5 in. base, 2 in. top. [14] 5 in. of 1-3-5 and 1¾ in. of 1-2.

The three great liners of about 50,000 tons each, which have been ordered by the Hamburg-American line, says an English exchange, are going to be fitted out with telephone exchanges of the most modern type, to which each cabin will be connected. This marks a very appreciable and further addition to the luxury of trans-oceanic travel.

THE ELECTRIFICATION OF STEAM RAILWAYS.*

By N. W. Storer.

A discussion of the subject selected for this meeting is one which almost invariably arouses the greatest interest. It is not because it is an electrical subject nor because it is about railways. It is because it is a subject that concerns every one who travels, for all such men have been subjected to the discomfort of riding behind a steam locomotive and are interested in everything that offers an improvement. Mr. Dooley says that any one may experience all the delights of riding in a sleeping car without leaving home. His advice is: "Throw a $2.00 bill out of the window, put a cinder in your eye and spend the night on the top shelf of your darkest closet." This is probably a slight exaggeration of the joys of present-day travelling, not due entirely to the steam locomotive, and although only the cinder and its attendant smoke and dirt can be eliminated from this picture by the use of the electric locomotive, most people are anxious to have the steam engine discarded even before they have seen an electric locomotive. When one has experienced the happiness of riding behind an electric on a hot day in the summer with all windows up and no smoke and cinders, he is ever after a convert to the electric.

The belief in the unbounded possibility of electricity has led to the idea that it is only a matter of a few years before all the steam locomotives will be relegated to the scrap heap. I used to share the belief, but the more I learn of the subject, the more respect I have for the steam locomotive and the work it is daily performing, and the greater the task of supplanting it with the electric appears to be; not that we are doubtful as to the ability of the electric locomotive to do the work, for we are certain that almost any railway can handle more traffic and do it better when operated by electricity than by steam. What, then, is the reason for doubting the speedy and general substitution of electricity for steam? Simply that the traffic on most railways at the present time would not pay for the large initial investment necessary for operating it by electricity.

A steam locomotive is an independent power unit requiring supplies only of fuel and water at intervals along the road. The electric locomotive is in itself powerless. It must have a power house back of it, with transmission lines to carry the power to it wherever it may be.

As the electric locomotive itself is much more expensive than the steam engine, and the power house and distribution system cost a great deal more, the investment for operating a heavy railroad by electricity must, therefore, be relatively very large, and unless the frequency of trains is high enough to maintain a good load factor on the line, substations and power house, it can scarcely pay. In other words, electric operation will pay if you can keep the apparatus working a reasonable percentage of the time, but will not pay if the percentage is small. A bank cannot pay interest on deposits when 90 per cent. of them are locked up in a safe. Similarly, a man who has a high-priced automobile that is run only 1,000 miles per annum, is paying a very high price per mile; much higher than the man whose machine covers 10,000 miles. Any apparatus must be used in order to make it pay for itself.

In comparing the cost of electric with steam locomotives, one railway official went so far as to say that the electric locomotives used to haul their trains cost not $35,000 each, which was the contract price for them, but $100,000 each, which was the cost of the entire installation, divided by the number of locomotives. This might appear to be the case, but it is not strictly correct, unless the cost of all the roundhouses, machine shops, coal handling and distributing apparatus, water tanks, etc., be included in the cost of the steam locomotives. Even that, however, would leave the cost of the latter motive power only a fraction of that of the electric. Under such a handicap, it cannot be expected that the railroads, which are laboring under great financial difficulties at the present time, will be able to electrify their lines except under conditions that absolutely require it or offer exceptional advantages.

Compulsory conditions are sometimes imposed by legislation to force a railroad to electrify to abate the danger and discomfort of operating steam locomotives through long tunnels. This was the immediate cause of the adoption of electricity as a motive power by the New York Central and the New Haven Railroads, for the entrance to New York City. This electrification cost a tremendous amount, but it has resulted in a most magnificent terminal, increased comfort and safety to the travelling public, and last but not least, in increased value of real estate owned by the railroads, which bid fair to make the electrification a paying investment. If this last proves to be really true, it will be most important, as it will make electrification much more attractive to the far-seeing railway officials and will result eventually in the electrification of the terminals in all the large cities.

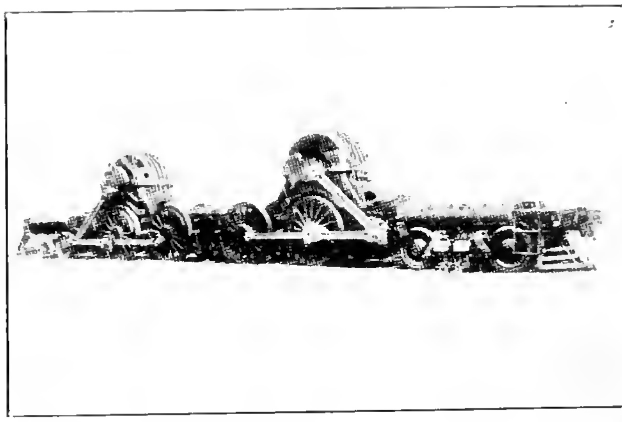


Fig. 1.—Running Gear and Motors, Pennsylvania Locomotive.

Beginning with the B. & O. R.R. at Baltimore, in 1895, a number of railroads have electrified tunnels which were a constant menace to the health and lives of the passengers and train crews. The St. Clair tunnel of the Grand Trunk Railway was electrified in 1906, and since then the Detroit River tunnel of the Michigan Central, the Cascade tunnel of the Great Northern, the Hoosac of the Boston & Maine, the Pennsylvania tunnel leading to the great terminal in New York City, have all been electrified in this country and are operating with great success, handling both passenger trains and the heaviest freight trains on both heavy grades and level track. These tunnels, in all of which, except the Pennsylvania, steam engines were originally operated, will be remembered by travellers as the places where every one was formerly nearly stifled. Now, either in the hottest summer day or the coldest of winter weather, the tunnel is welcomed as being the most comfortable part of the ride.

Another phase of the situation that is now receiving a great deal of attention is on the mountain grades where the heavy freight trains crawl up at from 5 to 10 miles per hour,

---

* Abstract of paper read before the Cleveland Engineering Society.

and the passenger trains crawl up at from 10 to 20 miles per hour. These grades always form the "neck of the bottle," and limit the amount of traffic that can be handled by an entire road. Even if it cost a great deal more to operate such grades by electricity, it would pay large dividends on the investment by increasing the capacity of the entire road.

Some one may wish to inquire how this electrification will increase the capacity of the entire road. It is effected by increasing the speed both on the up-grade and the down-grade, and by the greater reliability of service. On electrified divisions, the heaviest freight trains of 2,000 to 3,000 tons trailing load can readily be hauled up a grade of 2 per cent. by electric locomotives at speeds of 15 to 20 miles per hour, while the speed with steam locomotives would be usually from 5 to 8 miles per hour. This is possible because the electric locomotive has the power house back of it, but does not have to haul it up the hill. At speeds of 15 to 20 miles per hour it will have all the weight on drivers, and usually only as much as is necessary for adhesion. This being the case it can haul the trains at 20 miles per hour just as efficiently as at 10 miles per hour.

The steam engine, on the other hand, must haul its entire power plant up with it, and consequently, the higher the speed at which it operates up a grade, the less load it can pull, so that the economical speed is very soon reached. This appears to be 10 miles per hour, or less, for a 2 per cent. grade with heavy freight trains.

As the electric locomotive can take a train up a heavy grade much faster on account of its greater power, so it can take a train down the grade at a much higher speed because the motors can hold the train from accelerating by regenerating power and putting it back into the line to help some other train up the grade, or by using it up in a resistance on the locomotive. This saves the brake shoes for use in stopping the train only and thereby eliminates a great deal of the danger of taking trains down grades. Incidentally, the saving in power may be as much as 25 per cent., and the saving in brake shoes and general wear and tear of the equipment will also amount to a considerable item.

We, therefore, have the greatest confidence in inviting the attention of railroad officials to the electrification of their mountain grades, for if the traffic is at all congested there, electrification is bound not only to improve the service, but to give a very substantial return on the investment. The electrification work that has already been done is enough to show that electric locomotives can handle any kind of service from the heaviest slow speed freight service to the fastest of heavy passenger work.

The next question is, when will the great lengths of line between the terminals, and connecting terminals and grades, be electrified? That is something that will depend entirely upon the territory through which the road passes and the population of the terminals. I regard it as entirely possible, if not highly probable, that within the next ten years one can travel from Boston to Washington by fast trains over the New York, New Haven & Hartford and the Pennsylvania Railroads, behind electric locomotives. The New Haven is now operating all trains between New York and Stamford by electricity and is rapidly extending its electrfication to New Haven. It is also working at the Boston end of the line between Boston and Providence, besides having its Harlem River division and its immense freight classification yards operated exclusively by electricity.

The Pennsylvania has the vast network of lines on Long Island, besides the New York terminal, operated by electricity. It is now working on the Philadelphia terminal which must be electrified in order to increase its capacity. The bad tunnel at Baltimore must be electrified and the terminal at Washington must soon follow. With these city terminals all electrified, it is a foregone conclusion that the whole distance from New York to Washington will be equipped, as it would be impractical to have any breaks in the service; aside from this consideration, however, I believe that the population is so large as to make it a paying investment anyway.

Similar results will follow in other sections of the country, but more slowly and only as it is found by the railroads to pay a good return on the investment. That is the only thing that will make general electrification possible. No matter how desirable it would be to the public the railroads cannot electrify until it can be made to pay, either at present rates for freight and passenger service or by the undesirable alternative of higher rates for the improved service.

Just a word to people who are for compelling the railroads to electrify their terminals in large cities. Don't do it. The railroads in this country are fully alive to the advantages of the electrification for such situations; or if not now, they soon will be, for they are all studying the subject with the greatest care. I believe the matter can be safely left in their hands for a few years, at least, until the necessary plans can be made and all the innumerable details connected with the adoption of the new motive power are fully worked out. Without this careful consideration, the plans will be only half baked, and vast sums of money will be wasted and the full advantages of electrification will not be secured. When the railways of any city decide to electrify the terminals, they should work out a harmonious plan that will include all of them, so that power may be furnished from a common power house, and all equipment be interchangeable.

Electrification is bound to come on a large part of the railroads sooner or later in any case, but the steam railways should not be forced into it until they have had ample time to mature their plans.

There are many, many advantages from it, some of which are only beginning to be understood and some of which have never had the correct value. When all have been shown by experience to have certain definite values, and the best way to secure the advantages has been thoroughly worked out, the railroads will need no compulsion.

Following the foregoing paper, Mr. Storer presented a number of lantern slides showing various types of electric locomotives and discussed their salient features. Prominent among the list were the locomotives of the New York, New Haven & Hartford, the Pennsylvania, the St. Clair tunnel, the Boston & Maine and several European types. In general, the types were shown to exhibit the various forms of connections between the motors and the driving wheels, and to show the disposition of the weight, and the arrangement of wheels as affecting the riding qualities of the locomotive. The different forms of transmission between motors and driving wheels were distributed as follows:

1st. Gearing motors directly to the axles as on the ordinary street car. Among the locomotives of this type shown was one experimental locomotive for the Pennsylvania Railroad, the St. Clair tunnel and the Spokane & Inland, all being suitable for service at speeds below 30 miles per hour.

Operating with this type of locomotive with heavy motors mounted directly on the axle, is confined to low speeds because of the effect upon the track on account of the dead weight on the axle and the low centre of gravity.

2nd. The locomotive having the motors mounted on a hollow shaft surrounding the axle; these hollow shafts or quills being connected to the wheels through the springs.

The early New Haven passenger locomotives were of this type and have been quite successful, although some trouble was experienced with them after a few months of operation, on account of nosing. This was overcome by the addition of pony wheels at each end of the locomotive and the use of a toothed cam centering device.

This type of locomotive is very successful as long as the track is kept in good surface, for, in spite of the low centre of gravity, the motors are entirely spring borne, so that a direct shock is very seldom given to the track.

3rd. The third type of locomotive exhibited had the motors geared to the quill surrounding the axle, which is connected to the driving wheels through long flexible springs which permit the motor and quill to move a total distance of three inches in a vertical direction with respect to the axle. It is, therefore, possible to mount the motors directly on the truck frame. This form of locomotive is made for the New York, New Haven & Hartford, with but one motor per axle and with twin motors. Where one large motor is used, it is necessary to have double gears which require very accurate alignment. Where twin motors are used only one gear is required and both of the motors drive through the same gear. The small motors are found to be less expensive for single phase work and are lighter and easier to handle. On the New Haven Railroad, the same motors are used for both locomotives and multiple unit cars, excepting, of course, the motor frames which have to be adapted for a different type of mounting. This type of locomotive gives high centre of gravity and is an exceptionally easy riding machine. All of the weight above the wheels and axles is spring borne, and there being absolutely no tendency for nosing, the machine

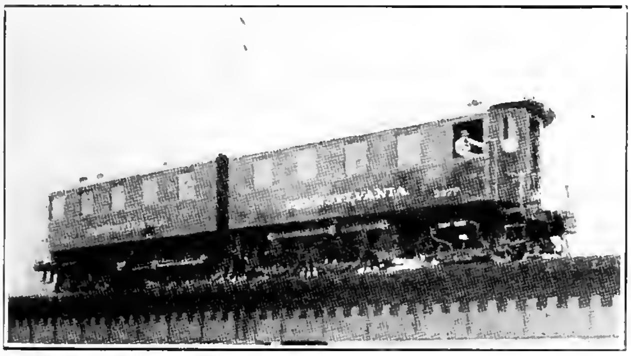


Fig. 2.—A Pennsylvania Railroad 160-ton D.C. Locomotive (600 Volts) for New York City Pennsylvania Terminal Operation.

is very easy on the track and is very comfortable to ride in.

Locomotives for both heavy freight and passenger work and for switching service with this type of drive were shown. It has been adopted as a standard by the New York, New Haven & Hartford, which has purchased over sixty locomotives of this type.

4th. Locomotives with motors mounted high in the cab and connected to the driving wheels through parallel rods from the motor to a jack shaft on the same level as the driving axles and thence to the drive-wheels by other parallel rods. The principal locomotive of this type which has been built is that of the Pennsylvania for use in the New York terminal. This is probably the most powerful electric locomotive ever built. It is used to haul trains of more than 800 tons weight up a 2 per cent. grade into the station. The locomotive weighs about 160 tons and has exerted a drawbar pull on level track of nearly 80,000 pounds. It is also able to handle the heavy passenger trains at 60 miles per hour on level track. This type of locomotive has the highest centre of gravity of any that have been built, and its operation on the track is similar to that of the best steam locomotives. A few years ago this would not have been considered very good by electrical engineers, but sad experience with machines having low centre of gravity has modified their opinions to a great extent and they are now glad to claim that such locomotives are as good as the best steam locomotives. This locomotive has established a wonderful record for reliability, there being only thirteen train minutes delay charged against the locomotives in the first year's operation. Such a record with 33 locomotives is little short of marvelous.

Another type of locomotive exhibited was that of the Italian States Railways, which connects the motors to the driving axles through a Scotch yoke. This is a form of side rod which is quite satisfactory for slow and moderate speed service. It has never been used for high speeds.

Another type is a combination of gears and side rods. This form is used for the locomotive built by the Oerlikon Company, in Switzerland, for the Loetchberg tunnel. The motors are geared to a jack shaft, instead of connecting to the latter by means of parallel rods as in the case of the Pennsylvania locomotives. This permits the use of a much higher speed motor and a considerable reduction in the weight and cost of the locomotive. It also enables the use of a single design of motor for various speeds of locomotives which may be secured by simply changing the gear reduction.

Some of the principal advantages of electric locomotives were discussed briefly and Mr. Storer expressed himself as being opposed to the extremely high wheel loads which are being used with the latest types of steam locomotives, and advocated the use of electric locomotives with wheel loads about equal to the maximum wheel loads on freight or passenger cars. It is claimed by many engineers that the destruction to the track is due almost entirely to the locomotives. These heavy wheel loads are probably necessary for the tremendous units that are now demanded, but the use of electric locomotives will permit the weight to be distributed so that no locomotive wheel need carry more weight than a car wheel in the same train. This will give the best possible results on the roadbed and will give more flexibility in locomotive units.

The matter of the arrangement of the commission appointed by the Department of Marine and Fisheries to investigate the water levels on the St. Lawrence River at and below Montreal, was brought up by Mr. Frank Carvell, at a recent session of the Commons, who stated that dredging had reduced the level in the harbor of Montreal very considerably from what it was eight or ten years ago. He suggested that the channel had something to do with the lowering of the water level in the harbor. The Honorable Mr. Hazen stated that the efforts of his department were now being directed to getting a thirty-five-foot channel. He had discussed the matter of the water level with officials of the department and had come to the conclusion that it was most desirable to obtain the best information on the point. On the recommendation of Messrs. Stewart and Forneret, of the department, he had invited Professor Haskell, dean of the Engineering School at Cornell University, to join them. Prof. Haskell had been engaged upon many river undertakings. The commission would confine its attention to the water levels between Montreal and Quebec, because the matter of navigation was urgent. A report was required without delay, whereas a commission with wider instructions would necessarily occupy a much longer period.

COSTS OF HAULING ASPHALTIC PAVING MATERIAL BY MOTOR TRUCKS AND TEAMS.

In his report on a proposed municipal asphalt plant for the District of Columbia, Mr. D. E. McComb submitted the following estimates on the cost of hauling asphaltic material in the District. The estimates are based on a haul over the streets of Washington. For hauling with a 5-ton motor truck, the following assumptions are made: Load = 6 dumps = 90 cu. ft. Cost per day, $12. Speed, 10 miles per hour = 1 mile in 6 min. Estimated time required to load, 9 mins.; unload, 7 mins.; tally, 2 mins.; total, 18 mins. For hauling with wagon and 2 horses the assumptions were: Load = 4 dumps = 60 cu. ft.; rate, $4.50 per day. Estimated time to load, 6 mins.; to unload, 6 mins.; to tally, 2 mins.; total, 14 mins. Estimated speed of team, 2½ miles per hour (1 mile in 24 mins.). The comparative cost per cubic foot of hauling asphaltic paving material for resurfacing and new work is estimated to be as follows:

	Motor truck. Per cu. ft.	Wagon. Per cu. ft.
½-mile haul	$0.0067	$0.0058
1 -mile haul	.0083	.0094
1½-mile haul	.0103	.0150
2 -mile haul	.0121	.0187
2½-mile haul	.0133	.0187
3 -mile haul	.0148	.0250
3½-mile haul	.0167	.0375
4 -mile haul	.0190	.0375
4½-mile haul	.0222	.....
5 -mile haul	.0222	.....

For hauling hot stuff on minor repair work the following estimates are given: Assumed haul by 1-horse cart for distances up to 2½ miles and by 3-ton auto trucks for distances beyond 2½ miles:

Cost of cart haul for average distance of 1¾ miles:

Estimated time required to—	Minutes.
Load	5
Unload	30
Tally	2
Total	37
To make trip and return	84
Grand total	121

Number of trips per day, 4.	Per cu. yd.
$2.50 ÷ 4 × 24 cu. ft.	$0.0260
Add 10 per cent. for delays	0.0026
Cost per cu ft.	$0.0286

Cost of 3-ton auto truck haul for average distance of 3 miles, 12 miles per hour:

Estimated time required to—	Minutes.
Load	7
Unload	45
Tally	2
Total	54
To make trip and return	30
Grand total	84

Number of trips per day, 6.	Per cu. ft.
$10 ÷ 6 × 45 cu. ft.	$0.0370
Add 10 per cent. for delays	.0037
Cost per cu. ft.	$0.0407

The estimate for hauling asphaltic paving material for patching work is based on the following assumption: One horse cart: Load = 24 cu. ft. = 3 dumps, 8 cu. ft. each; cost per day, $2.50; estimate of speed, 2½ miles per hour; average haul = 2½ miles.

Estimated time required to—	Minutes.
Load	5
Unload (averaged)	30
Tally	2
Total	37
To make trip and return	120
Grand total	157

	Per cu. ft.
Number of trips per day, 3; cost per cu. ft. = $2.50 (÷ 3 × 24)	$0.0347
Add 10 per cent. for delays	.0035
Total cost per cu. ft.	$0.0382

REFUSE DESTRUCTION AND STEAM RAISING.

The result of an official test of a duplicate front-feed refuse destructor at Nuneaton, which was first utilized for steam-raising purposes in April of last year, appears in the report for 1912 of Mr. F. C. Cook, borough engineer and surveyor of that town.

The contractors were Messrs. Heenan and Froude, Limited, of Manchester, and the cost of the furnace, apart from buildings, was $3,902.50.

The main results show that during the eight hours of the test the furnace dealt with 61.5 lb. of refuse per square foot of grate area per hour, which is equal to nearly 50 tons per day, and that the water evaporated per lb. of refuse consumed, from and at 212 deg. Fahr., was 1.727 lb.

Very little use was made of the spare coal-fired boiler after the completion of the duplicate destructor. Altogether, the destructors worked for 302 days, and dealt with 2,711 wagon loads and 4,654 cart loads of house refuse, together with 99 loads of trade refuse, equal to a total weight of about 6,382 tons, and representing about 88 per cent. of the total house refuse collected.

The gross cost of labor in destroying the refuse was 36c. per ton, against 42c. in 1911. In 1911 the net cost (excluding capital charges, and deducting the saving in coal) worked out at $1.18 per ton; but last year there was an actual saving of $621.25 during the time the destructor was at work, as compared with what the cost of raising steam by a coal-fired boiler would have been over the same period. The result was mainly accounted for by the enhanced price of fuel—viz., 80c. per ton against 55c.—and to the very great increase in the quantity of sewage pumped, which would have led to a corresponding increase in the weight of fuel used in generating steam.

The sum of over $146 was realized by the sale of tin and galvanized-iron scrap. This is very nearly all profit, as this waste material was previously burned in the tips.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."
Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.
London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, APRIL 10, 1913. No. 15.

CONTENTS OF THIS ISSUE.

GOVERNMENT SUPERVISION OF DAM CONSTRUCTION.

During the recent flood disasters in the United States at least one dam was reported as having given way, and there were many cases of panics and excitement in numerous towns over reports of the collapse of others. To what extent such panics and fears are justifiable we do not know, but there have been instances in the past in the United States of careless dam construction, disastrous to human life, which partly justifies a distrust by the people of such engineering structures. It all reflects to a certain extent on general engineering, and should be prevented. We have government supervision of buildings, etc., for the safety of the people. Why not —and more so—have it for the design and construction of dams if they endanger in their failure human habitations and life? An instance of what such supervision could have prevented was the Austin dam failure, which many of our readers will remember took place in the United States in 1911. Investigation after the accident brought out the facts that a portion of the dam which drawings showed thirty feet thick at the base was only twenty feet thick; that the existence of a cut-off wall or key, which was supposed to be four feet thick and extend four feet into bed-rock across the whole upstream face of dam could not be found.

Incompetent engineering in the above case and panics in the recent flood disasters in the United States should lead governments to adopt means of exercising skilled engineering supervision over dam construction. Ordinary static stresses in dam design are easy enough to figure, but the foundations and joints bring in elements of doubt that require to be met by liberal factors of safety in design. There should be absolutely disinterested inspection to see that improper economical risks are not taken for the sake of financial questions involved.

Such accidents and panics reflecting on the profession are not desirable, and engineers should be the first to applaud competent engineering and government supervision that would make impossible mistakes which endanger human life. Such a course serves the twofold purpose of increasing the people's confidence in their safety and preventing possible disasters which reflect on the ability and honor of the whole engineering profession. It would still further safeguard engineers in as far as when pressed for reasons of economy to lower factors of safety in design they would know it was impossible, due to government inspection.

UTILIZING THE SUN'S RAYS FOR POWER PURPOSES.

Most engineers have listened with interest at some time or other to tales of the practicability of gathering and utilizing the heat and intensity of the sun's rays in tropical countries for power purposes. Recalling the ancients and fairy tales of wonderful sun-glasses that were going to burn up ships and wreak destruction on those who ventured to oppose them, further memories come of years that have passed, with innumerable engineers longing at times to make a servant of the intense tropical heat of old "King Sol." We dwell on the fruitlessness of it all; probably recall that, while scientists in laboratories in a small way have successfully experimented, yet no practical results have ever followed, and, consequently, we are inclined to dismiss the possibilities of the scheme as hopeless.

While no startling success has yet been met with in the way of converting the energy of the sun's rays into useful work, yet it is well to remember that every perfecting of low-pressure steam engines brings the possibilities of that goal nearer. There have been advances in that line of late years, and it is of consequent interest to hear of a company which started construction in 1812 in Egypt of a 100 horse-power pumping plant to be operated by boilers obtaining fuel from the sun's rays. The history of the plant as given lately in London, England, by an official of the company is that on completion of the plant and after three days' successful running the specially designed zinc boilers, which acted satisfactorily in the United States, were unable at Cairo to stand the heat. They leaked, and had to be discarded, and the plant was at a standstill pending the delivery of cast-iron boilers ¼ inch thick. He hoped these would be fitted and the plant start running afresh on June 1st next. They had selected cast-iron boilers in order to obtain quicker delivery. In future they would use dished steel-plate boilers, for the manufacture of which it would be necessary to procure beforehand the required sets of dies. The first cost naturally was a heavy one, being probably twice that of a steam plant of equal capacity. As to operating, it might be stated that when coal was at the price of $2.50 per ton, the sun-power plant could compete with it; when coal cost more, then the sun-power plant made a profit. Starting the plant at 6 a.m., they had steam at 6.15. Starting at noon, with cold water, they had steam in three minutes. The low-pressure engine used was a special type of engine, a d Prof. C. V. Boys, their consulting engineer, while feeling satisfied the boilers would substantiate in practice what had been advanced in regard to them, believed it was on the utilization of their steam that they were bound to concentrate their attention.

The report does not sound encouraging, but when we consider what the successful operation of such principles of design would mean to Egypt and other tropical countries in the way of irrigation and pumping possibilities, we cannot help wishing the enterprise all kinds of success.

Wireless and other modern inventions help one to believe that modern ingenuity will in some way find means to economically capture and convert into more useful energy the sun's heat of the tropics.

THE PACIFIC HIGHWAY.

The agitation and propaganda for good roads carried on by Highway Associations throughout the Dominion have invariably had for their primary and chief argument (and an immediately pressing argument) the mutual benefit to be derived by settlers and farmers and nearby residents in cities and towns through increased and easier trade facilities. Increased land values for farms, due to increased accessibility, have had prominence, and the importance of automobile and pleasure trips has been secondary—and rightly so—in all highway promotion. The exception to the above that might be said to prove the rule, is the case of "The Pacific Highway" in the Rocky Mountains. The proposed route of this highway is from Hazelton, in Northern British Columbia, to Yuma, Arizona, and ultimately on to Mexico. The British Columbia and California legislatures are in favor of the scheme, Washington is inclined to be favorable, and, provided the Oregon and Washington legislatures signify their willingness, the building of a splendid international highway, three thousand miles long extending from Hazelton southwards will soon be a certainty. In the meantime it is partly under construction in many parts already.

Considering the physical difficulties and expense of road building in the mountains, the slight population along great parts of the route, the certainty that fertile spots will only be found intermittently and that the major portion of the road must always run through uncultivatable mountain region, one might expect difficulties and discouragement in persuading legislatures to vote money for such a task. It is in the fact that the association which is stimulating constructions on the Pacific Highway bases in great part its arguments for the prompt construction of same on benefits to be derived from tourist travel that it differs from most highway organization. The vice-president of the association, Mr. Todd, in a recent address in British Columbia dwelt strongly on these benefits. Tourists from North America spent in Europe annually more than thirty times the amount of the expenditure of the Provincial Government for last year. Motorists from America and from England went regularly to Europe for motoring trips, and the amount which was thus spent out of the country—which might be spent in it—could be easily ascertained as an enormous sum. The Pacific Highway would tempt all these and many foreigners more to tour on the Pacific slope. In Mr. Todd's opinion 1916 will see not less than ten thousand foreign motor cars touring on British Columbia roads, and that these will do the Province a thousand times more good than any damage they may incidentally do the roads. Every one of these tourists will be a possible investor, and, presuming that these ten thousand cars average four passengers apiece and stay an average of thirty days at an expenditure of $10 a day for each person, $15,000,000 are at once in sight as a revenue which tourists must pay here for bare necessities.

Those who have ever been through the mountain districts of Europe or spent any time in the Canadian Rockies realize and will agree with him in what a tremendous asset British Columbia's scenery is, once they have accommodation and means to make travel in the remoter parts comfortable. The British Columbia legislature for years has spent more annually on trails and road-making than any other province in the Dominion. The work has been well done, and it has been rather a heart-breaking and long fight, contesting with nature as seen in British Columbia.

The people and province will reap the benefit in the end, and the present support of the Pacific Highway is only another laurel in British Columbia's crown for energetic and unswerving progress towards better means of communication throughout the Province.

The mail and passenger steamer "Lintrose," which has been constructed to the order of the Reid Newfoundland Company, of St. John's, Newfoundland, by Swan, Hunter & Wigham Richardson, Limited, at Newcastle-on-Tyne, has successfully completed her trial trips, and is on the point of sailing for St. John's to take up her service of carrying passengers and mails between Newfoundland and the mainland.

The steamer is exceptionally strongly constructed for running through the ice which she will frequently find on her route, and is very finely modelled. She has accommodation for 180 first-class and 150 second-class passengers.

ALKALI-RESISTING CONCRETE.

Tests which have been carried on by the engineers of the United States Reclamation Service to develop a modified cement that would resist the action of alkalis and be cheaper than the commercial Portland cement is in the west were recently embodied in a paper read before the International Association for Testing Materials, and reads as follows:—

Sand Cement.—A good cement, comparing favorably in strength with the Portland cement used in its manufacture, can be made by regrinding Portland cement with certain proportions of inert materials (such as rock or sand, granite, basalt, sandstone, and tufa), the mixture being ground to a greater fineness than that of the original cement. The amount of diluting material may range from 30 to 50 per cent., depending on the fineness of grinding practiced.

In connection with the materials used in these tests, special interest has of late attached to the use of puzzolanic materials such as tufas, in which a portion of the silica is considered to be in "soluble" form such that it will enter into chemical combination with the uncombined lime in the Portland cement with which it is ground. That such materials can be used to good advantage in making a cement of this class has been proved by their successful use for this purpose in the construction of the new waterworks system for the city of Los Angeles in California. They are also of interest as being of possible assistance in the solution of the alkali problem. They are, however, of a lower specific gravity than most of the other materials (such as quartz sands, granites, etc.) which are generally available for making a cement of this class; and in the writer's opinion it has not yet been proved that they should be chosen in preference to these latter materials when both are available, as, on account of their lighter weight, they would tend to produce a cement of a lower strength than these heavier and harder materials.

As a result of the above investigations the use of cements of this general class has been adopted for two large masonry dams, and for the auxiliary works in connection with a large earthen dam whose construction work is about to be commenced by the Service. Grinding mills will be erected and the sand-cement manufactured at the sites of these structures, using Portland cement purchased in the usual manner, and the field materials available at these points.

With regard to the general use of cements of this class, it is evident that they are not applicable for use on small structures in scattered locations, on account of the cost of erection and operation of the grinding plant required. In the case, however, of a single structure requiring a large amount of cement, and located at a point where the cost of Portland cement is high, it would appear that they can be safely used, provided proper care is exercised in the selection of materials and in the process of manufacture, with a considerable saving in the cost of the structure as a result.

Disintegration of Concrete by Alkali Action.—Among the problems met by the engineers of the Reclamation Service, as well as by other engineers in the arid regions of the Western States, is that of the destruction of concrete by alkali action under certain conditions and in certain localities.

These arid regions contain numerous deposits of so-called "alkali," and in many places the ground waters are strongly impregnated with these salts in solution. This general term "alkali" is used to include a variety of substances, of which the salts of sodium and potassium are among the most common, although salts of calcium and magnesium are also included in the general term. As the use of cement and concrete in these regions is a comparatively recent move, any effect that this alkaline water might have on concrete structures with which it comes into contact has until recently been a matter of conjecture if it has been considered at all.

Investigation of the subject, in the form of analysis of samples representing the alkali deposits and the ground waters where disintegration has occurred, shows that the sulphates, and especially sodium and magnesium sulphates, either singly or together, are the principal salts acting to cause this disintegration. The chemical action involved seems to be analogous to a considerable extent to the destructive action of sea water on concrete, in which magnesium sulphate is considered to be the principal salt acting to cause disintegration.

The conditions most favorable to attack appear to be where the concrete in small structures, such as culverts, etc., is subject to the action of seepage water coming through from the soil at the back, or of water which has become highly saturated and concentrated owing to light and sluggish flow in the water-courses in which the structures stand. Conditions of alternate exposure to water and air as produced by a varying flow in these water-courses are also especially favorable to the development of this action. It is hardly necessary to add that the character of the concrete also has a marked effect on the extent to which the destructive action will take place, a dense, well-made grade of concrete being, of course, more impervious and less readily attacked than concrete of a less dense, porous nature.

On a recent visit by the writer to one of the projects of the Service, where alkali conditions are prevalent, a marked contrast was noted between a tunnel lining on this project, which was in excellent condition, and another on private work in the same vicinity, which had been badly attacked by alkali action, and where the concrete work was evidently of an inferior quality. It is also probable that the character of the materials used for concrete aggregates, as well as the workmanship, may have some influence in the matter.

To refer briefly to the best method of remedying the difficulty, the main point is the production of a dense and impervious concrete, such that seepage of the alkaline waters through the concrete will be prevented. As to whether this can be best brought about by the use of a specially prepared rich and dense mixture without any other form of treatment, or whether some form of waterproofing treatment will be the best solution, is a question now under investigation.

TELEPHONES FOR FIRE PROTECTION.

According to the British Columbia report of the provincial forest branch it is their intention to construct telephone lines and pack trails where they are most needed throughout the province as a protecion from forest fires. Over the greater part of British Columbia neither of these essentials is at hand. As a means of rapid communication, the telephone is obviously the most desirable, considered from the standpoint of usefulness and cost of construction and maintenance. For woods work, a single wire (ground circuit) strung on trees has proven very satisfactory, and may be constructed at a remarkably low figure considering the protection afforded. In the national forests of the Western States such lines have been built at a cost per mile varying from $30 to $80, depending on the accessibility of the country through which they run. Branching from trunk lines as mentioned above, there may be built cheap, temporary lines to "lookout points." A system of telephone lines is a tremendous aid in the prevention of forest fires, but should be accompanied by a system of good roads.

DESIGN OF AN AMMONIA-COMPRESSION REFRIGERATING MACHINE.

Assuming average temperatures of 70 deg. and 0 deg. F. for the ammonia in the condenser and evaporator, and allowing for losses at the regulating valve, influx of heat into the pipe connections and cold parts, and by superheating in the compressor, 450 B.t.u. per lb. of ammonia circulated may be taken as available refrigerating effect. Taking one ton of refrigeration as 322,000 B.t.u. (In the United States 288,000 B.t.u. is the recognized figure, based on a ton of 2,000 lb. and 144 B.t.u. per lb. of ice melted) per day of 24 hours, then $322{,}000 \div (450 \times 24 \times 60) = 0.497$ = pounds of ammonia to be circulated per minute per ton. Taking the volume of 1 lb. of ammonia vapor at 0 deg. F. to be 9.1 cu. ft., volume of ammonia vapor to be circulated per min. $= 0.497 \times 9.1 = 4.53$ cu. ft. = compressor displacement per min. per ton of refrigeration per day. This displacement is for machines of 2 tons of daily ice-making capacity; for machines of from 5 to 100 tons capacity the displacement ranges from 4.4 down to 4.1.

The maximum piston speed, because of the fact that self-acting mushroom valves are used, is about 350 ft. per min. The length of stroke of the piston should be from 2 to 2.4 times the diameter of the cylinder.

The cylinder walls, of cast iron, should be from 1 to 1⅛ in. thick to insure good working with ammonia at the pressures generally employed. With very close-grained iron, the thickness may be as little as ⅞ in. Liners may be used to advantage in cylinders over 8 in. in diameter. These should be not less than 1⅛ in. thick, and in 21-in. cylinders may well be 1½ in. thick to provide for stiffness, as they are supported only at the ends. The pores of compressor castings may be rusted up by subjecting them to a solution of sal ammoniac under a pressure of 200 lb. per sq. in.

The diameter of the suction valve may be made a little above, and the delivery valve a little below, one-third the diameter of the compressor cylinder. The piston rod should be made of steel having a tensile strength of from 78,000 to 90,000 lb. per sq. in., and an elongation of at least 21% over 6 in. The diameter of the rod should be one-quarter the diameter of the cylinder.

The mean effective pressure for an ammonia compressor working under conditions suited for ice-making may be taken as 60 lb. per sq. in.; from this the probable I.H.P. of the compressor may be computed, and that of the engine driving it will be about 25% greater. Also, I.H.P. of engine $= (2 \times$ ice-making capacity of machine in tons per 24 hours$) + 10$. For machines of less than 10 tons daily capacity, add 7 instead of 10.

Assuming the condensing water inlet temperature not to exceed 65 deg. F., then, for each ton of ice-melting capacity (ton of refrigeration) 60 to 70 running feet of 1¼-in. internal diameter pipe will be ample for submerged condenser pipe, and 90 ft. for pipes exposed to the air. The grids of coils for atmospheric condensers may be spaced 12 to 20 in. apart, 12 to 20 ft. long, and 8 to 12 ft. high.

Supposing that the brine is being cooled under conditions similar to those which exist when ice is being made, then for each ton of ice-melting capacity allow 125 to 150 running feet of 1¼-in. internal diameter pipe, it being understood that the greatest possible care is taken to insure an efficient circulation of the brine.—Condensed from a paper read by J. Wemyss Anderson before the Institute of Mechanical Engineers, November 22, 1912.

ARRANGEMENTS OF ROOFS FOR ENGINEERING WORKS.

A paper recently read by Mr. H. N. Allott, M.Inst.C.E., before the Manchester Association of Engineers, dealt with the construction and methods of roofing of engineering works as follows:—

Saw-tooth roofing, where possible, is usually arranged with the glazing facing north so as to prevent the direct glare of the sun through the glass. The principal advantage of the saw-tooth roof is that by its use a more evenly lighted and cooler shop is obtained. The amount of glazing to be allowed for in a roof of the ridge type should be not less than about 50 per cent. of the area of covering, and in districts with an atmosphere like that of Manchester this may be increased with advantage to 60 per cent or 70 per cent. The glass should be equally distributed on both sides of the roof, as by that means a more even illumination is obtained than when all the glass is placed on one side of the roof. Another advantage of distributing the glazing is that the direct glare of the sun and consequent heating of the shops in summer is minimized.

The roof covering in this country usually consists either of slates, asphalt felt, or corrugated iron. For slates or corrugated iron the roof generally is given a rise of not less than a quarter of the span, for if made of a flatter slope rain and snow are liable to blow in at the joints. For felted roofs the roof may be practically flat if the joints are properly made with mastic, and it is only necessary to give a fall of one or two inches to the foot to allow for drainage. Galvanized corrugated iron is usually only used in this country for buildings required for temporary purposes, and when used should be carefully painted before and after fixing, and afterwards properly maintained, as otherwise its life is only short. Slating, when used, may be laid on battens nailed to spars, or to boarding nailed to the purlins. When laid on spars the slates should be pointed on the underside with hair mortar. When laid on boarding the boarding should be covered underneath the slates with sarking felt.

An alternative to natural slates are asbestos slates, formed of a mixture of asbestos and cement, several reliable makes of which are now on the market. These are made about 16 in. square, and are best laid either with the diagonal parallel to the slope of the roof, or in what is termed "honeycomb" fashion. The point of the slate should be cut off, as it is otherwise liable to be broken by anyone walking on the roof. It is necessary in all cases to see that proper lap is given to the slates, and this is especially the case where asbestos slating is used, as owing to its smooth surface the roof is more liable to leakage, where proper attention is not given to this.

An alternative to galvanized corrugated iron sheeting has also recently been supplied by corrugated sheets of asbestos composition, which can be obtained up to 10 ft. in length and 27½ in. in width.

In the author's opinion, asphalt felt laid on thicknessed, grooved, and tongued boarding forms the best covering for engineering shops and similar buildings. Besides being cheaper than slating, it is not damaged like slating by men walking on the roof to attend to skylights, and for similar purposes. The use of felt of good quality is permitted by the building departments of most local authorities, although one or two treat it as not being sufficiently incombustible. The felt is laid in mastic and nailed to the boarding, the joints being lapped about 4 in. One thickness of stout felt will make a satisfactory job, if properly laid and if proper

attention is given to maintenance, though the roof is generally covered with an extra thickness of a thinner quality of felt where a thoroughly good job is required. One advantage of the use of felt is that a considerable saving can be effected by forming the gutters in felt, instead of using cast-iron gutters; this is especially the case in roofs where large valley gutters are required. A considerable amount of lead, required for flashing at various parts of the roof, can also be saved. The only attention required to be given to felted roofs is a coat of varnish at intervals of about five years.

The comparative costs of the before-mentioned types of roof coverings are as given below, per square yard of area covered:—

20 B.W.G. galvanized corrugated sheeting	$ .79
Asbestos corrugated sheets	1.28
Slates laid on spars	1.15
Slates laid on match-boarded on underside	1.52
Slates laid on 1¼-in. boarding, including sarking felt	1.58
Asbestos slates cost about 12 cents per square yard less than natural slates.	
Asphalt felt, one layer, thick quality, laid on 1¼-in. boarding	.97
Asphalt felt, one layer thick, one layer thin quality, laid on 1¼-in. boarding	1.22

The roof glazing is best carried out with patent glazing, of which there are several satisfactory makes on the market, the alternatives to patent glazing being wood or T steel glazing bars, the glass being puttied in. The patent glazing is preferable, as with puttied bars the putty becomes defective and the glazing leaky, unless systematic attention and painting is given. The best systems of patent glazing consist of a steel bar, to which is fixed a lead flashing, which is worked down on to the glass to form a weather-tight joint. In most cases the glazing bar is sheathed all over in a lead casing, the ends of which are soldered up, thus obviating the necessity of painting. The bars should be galvanized before the sheathing is put on. Except in the case of vertical or steep-pitched glazing, as in the case of a saw-tooth roof, it is not advisable to joggle the glazing bar to form a lap in the glass. If this is done on a flat-pitched roof leakage is liable to occur, owing to capillary attraction between the two panes of glass. Where it is necessary to form a joint in the glazing on a roof of ordinary pitch, it is better to step the glazing bars. The roof glazing is best carried out with wire-wove glass, which holds together and does not drop if a pane is broken.

PANAMA PACIFIC EXPOSITION.

The Pacific Gas and Electric Company has been awarded a contract for the supply of gas, electricity and steam for the time and period of the Panama-Pacific International Exposition Company. The contract is as follows: "Contract signed between Panama-Pacific International Exposition Company and Pacific Gas and Electric Company, under which the latter will supply exclusively during the next 3½ years all electric current required for power and lighting purposes during the term of the World's Fair in San Francisco in 1915, and during the period of construction and dismantling. Present estimates are that the Exposition will require 20,000 horse-power. Gross amount of this business estimated at $500,000. Simultaneously contracts also made with Pacific Gas and Electric Company, for all gas and steam required by Exposition."

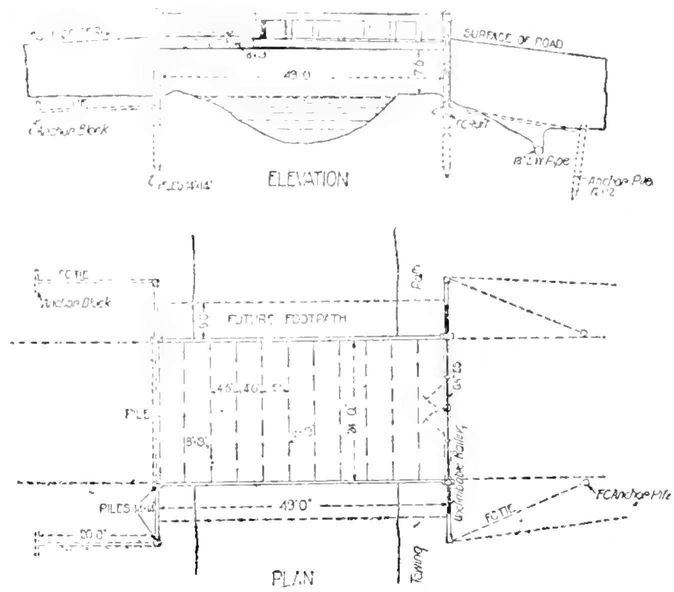
REINFORCED CONCRETE BRIDGE.

A description of a small reinforced concrete bridge with special features of design is given by Mr. D. M. Jenkins, Assoc. M. Inst. C.E., of Neath, England, in an issue of Ferro-Concrete. The following is an abstract from same.

The bridge has a span of 49 ft., a width between parapets of 24 ft., and a clear headway of 7 ft. 6 in. above the towing path of the canal.

No solid foundation being available at a moderate depth, the drawings provided for ten ferro-concrete piles, 14 in. by 14 in., which were made on the spot, to be extended upward as columns for the abutments and wings, the wing piles being tied to anchor piles, 12 in. by 12 in., by ferro-concrete ties. The accompanying drawings make clear the structural features of the bridge.

The contract length of the piles was 23 ft., which was based upon the indications of a trial shaft sunk in the marsh about 15 ft. distant from the site of the north abutment, strong gravel having been found at a depth corresponding to a length of pile of 20 ft., and provision made for entering 3 ft. into the gravel. Above this formation the whole of the excavation for the shaft was in a rather soft alluvial clay.



Reinforced Design.

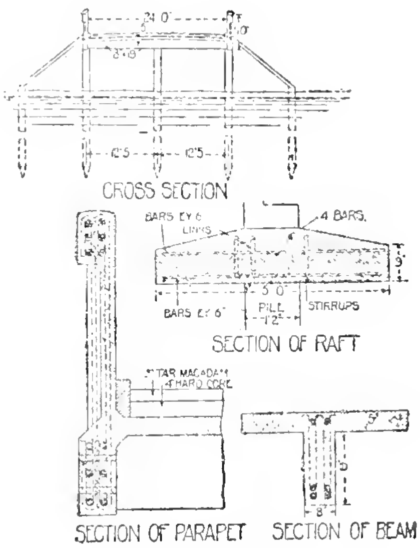
Pile-driving was commenced on the south bank of the canal, and good results were obtained, the final set, measured for ten blows of a 2-ton monkey with a drop of 3 ft., being ⅜ in. to ¾ in. On the north bank, however, no satisfactory set was forthcoming down to and at the contract depths—nothing better in fact than from 3 in. to 6 in. for ten blows. It was then decided to drive an experimental pitch pine pile, 40 ft. long by 14 in. square, on the line of the abutment and near the central pile, but no better result was obtained. The absence thus indicated of the stratum of gravel found in the trial shaft, although it had clearly been reached below the south bank, farther away from the shaft, pointed to a deep "wash-out" of that deposit within very narrow limits; and in view of the uncertainty as to the extent of lengthening of the piles required to reach the solid, the desirability of adopting some alternative plan was considered.

Eventually it was decided, in consultation with Messrs. L. G. Mouchel and Partners, not to lengthen the piles, but to rely upon them as they were to carry a load of 10 tons each and to carry the abutment and wings on a ferro-con-

crete raft, 5 ft. wide, and from 9 in. to 14 in. thick, which was designed to take the remainder of the total load. The raft was formed in situ on the puddled bank of the canal, which is known to have been constructed over 100 years back, and is thoroughly consolidated and sound. The calculated maximum load on the bottom is 0.8 per ton square foot, and the estimate formed of the safe load which the bank could carry has been fully borne out by the result of the test applied (which is described later), and the subsequent traffic over the bridge.

The abutments and wings are built up of ferro-concrete columns, curtain beams and curtains, thoroughly braced together and to the ferro-concrete raft, the wings being formed with a slight batter and finished off with a rectangular coping, also of ferro-concrete.

The superstructure consists of two pilastered main beams, which form the parapets; cross beams, spaced 4 ft. 6 in. apart; and a continuous decking, 5 in. thick, with cambered upper surface—all moulded in situ so as to form a monolithic whole. Holes are left in the parapets, two to each bay, to enable ferro-concrete brackets to be bolted on to carry future footpaths.



Reinforced Design.

The roadway is formed of a hard core, 4 in. thick, of local sandstone, broken to 2½-in. gauge, and a surface coat of tar-macadam, 3 in. thick, a blue brick channel being laid on each side to carry off surface water. At the north end of the bridge self-adjusting unclimable iron railing and a pair of iron gates are fixed, the gate pillars being bolted down to the decking, and the standards of the railings similarly secured and attached to the ferro-concrete piers by means of ¾ in. diameter bolts passing through them and enclosed in lengths of galvanized iron tubing.

The approach road on the south side is carried on an embankment, with 1 to 1 batters, covered with sods obtained from the marsh; and on the north side, after the preliminary filling to counteract the outward thrust of the abutment during the process of testing, the surface was brought up to the required level by the tipping of town refuse, and a temporary sleeper road formed. Part of the "Back Cut" of the canal has been enclosed by 18-in. stoneware socket pipes, bedded on and surrounded with cement concrete, and the toes of the embankment are supported by retaining walls of rubble masonry.

In his article Mr. Jenkins points out that there were two special conditions governing the design of the bridge: (1) The superstructure had to be kept up so as to give a clear headway of 7 ft. 6 in. in accordance with the requirements of the Neath Canal Navigation, who have statutory powers, and whose consent had to be obtained in the first place for the crossing of the canal; and (2) the surface level had to be kept as low as possible so as to avoid excessive gradients on the approaches. To meet these opposite conditions, the arrangement was adopted of two main girders, carried up as parapets with cross beams spaced sufficiently close together to keep their depth within the required limits. Further, for a number of years only limited cart traffic will be required to pass over the bridge, but later on, when the marsh land has been developed, access for the general public will have to be provided. To meet this condition the bridge has been formed to the by-law width of carriageway —namely, 24 ft.—and provision made, as before mentioned, for adding when required a footpath to be carried on cantilevers outside each parapet. This is an economical arrangement, while at the same time it admitted of the distance between the road surface and the underside of the main beam being kept to a minimum—the alternative having been to space the main girders 36 ft. apart to increase their depth and strength, and incidentally the gradients of the approaches, and to incur practically the whole cost of the finished bridge long before it was necessary.

MOTOR FUELS AND THEIR FUTURE PRICE.

Mr. G. S. Sayner, in a recent lecture to the members of the Harrogate and District Automobile Club, pointed out that benzol was one of the first products of the distillation of coal tar, and was obtained in very large quantities on the Continent, and to a limited extent (now increasing largely) from the recovery plants fitted to ovens in which metallurgical coke was produced. This hydrocarbon had the formula C_6H_6, and was only a little less volatile than petrol, 1 lb. giving 4.5 cubic feet of vapor at normal temperature and pressure. Like all the volatile hydrocarbons, there was a certain amount of variation in the determinations of its calorific value—from 18,188 B.th.u., according to Thompson, to 17,780 as determined by the bomb calorimeter. The commercial washed or rectified 90 per cent. benzol was the only kind really suitable for motors, though Mr. Sayner said he had run a car on the crude 60 per cent. unwashed. There was no difficulty in driving motor carriages of any description with 90 per cent. benzol as the principal fuel. With regard to napthalene, coming from various products of the distillation of coal, it contained 93.7 per cent. of carbon, and required melting or vaporizing, and special apparatus for obtaining the explosive mixture. One advantage was its low cost—0.32d. per horse-power-hour in a recent test. Mr. Sayner added: "In looking into the future I see great possibilities for napthalene, as the source (coar tar) from which it is obtained is more likely to be equal to the demand. Those in the North of England especially are in a favored position, as the tar of the coal is full of napthalene. The quantity required for motor purposes could be easily provided."

CANADIAN PULP AND PAPER MANUFACTURERS.

The Canadian Pulp and Paper Manufacturers' Association has been formed for the "object of gathering statistics on the possibility of the world's market, the collection of rainfall data, and to co-operate with the Dominion Government in the establishing of laboratories for forest products."

EXPLOSIVES.

By J. K. Moore.

(Continued from page 534, last issue).

After the hole is loaded, or nearly so, put in your fuse and see that the powder in the fuse is exposed and dry. After placing the fuse in the powder, put in some more powder to insure ignition and tamp in the usual way, using wood or copper rammer. If the hole is deep, use double fuse, place the end in a cartridge of powder and see that it is tightly tied on.

Powder does not require a detonator or cap. It ignites from a spark. Powder will not explode if wet.

When a shot has to be set off at cross-roads, or where the traffic is heavy, men should be sent out along the different roads to stop the traffic. They should have a flag and signals should be arranged so that the powderman could be warned when everything is clear. Even with this precaution the usual calls of alarm should be given.

Electricity and Wire Fuses.—When using electricity, or a battery and wire fuse, in setting off shots, never connect up the wires to the power wires or battery until every one has gone to a safe place as there may be a leakage and a premature shot follow. Platinum electric fuses can be procured almost anywhere for black powder, and combination fuse and detonator for dynamite. Be very careful that you get the very best and be sure you keep them dry.

I am convinced that in quarry work and heavy blasting, wire fuses, cable and battery, is the safest method of exploding powder or dynamite, because immediately you disconnect the wires of the cable from the battery there is no danger from fire in the drill hole, as there would be from ordinary fuse, even in case of misfire. If you have a misfire you can go over your wires immediately after without danger. Wire fuses are placed in the charges the same as other fuse and the same care exercised when tamping so as not to cut the wire. In making your connections, see that the ends of the copper wires are clean and bare, raise every connection thus made from the ground by placing a dry piece of wood or stone under, as the damp soil may ground the current, and be sure you do not allow two connections to touch or else you will cause a short circuit.

Mis-shots.—Mis-shots are shots that have failed to explode. The causes are manifold. It may be faulty fuse, poor detonators, carelessness in pulling the fuse out from the cap or charge. Or in electricity, it may be from overcharging your battery, that is, having more shots connected up than your battery can stand. It may be the platinum in the cap, broken wires, grounding or short circuit. But whatever the cause, care should always be exercised in returning to the shot if ordinary fuse is used. Several hours should always elapse between the time of lighting and returning in such cases, as there may be smouldering, and catch the powder in the fuses again. In electric fuses, it may be better to allow a few minutes, but be sure you disconnect the battery. If you cannot find the cause and have to put down another primer or fuse in the drill hole, be very careful not to remove all the tamping, and, in the case of dynamite, it is a dangerous practice at best. In black powder, use a copper picker used for the purpose, and be sure you moisten the tamping.

It is also dangerous to drill a new hole near the misfired one, that is, within two feet, hoping that it may explode the other one, when it (the second shot) explodes, as the shock from the drilling may set it off prematurely.

Taking Out Charge.—Always follow the safest way, and that is, drill a new hole several feet away from the one that has misfired, never closer than three feet, drilling down to about the level of the charge in the other. Then load lightly and fire. Then you will be able to get a new primer down to the misfired charge in the other.

In partly exploded shots, do not try to drill the hole out to make room for another charge. Simply put in some more explosive, another primer, with no tamping, and set off. Care must be used not to put in too much dynamite to spoil the hole for further use.

There are three or four practical ways to break boulders. The first is by drilling a small hole called a plug and putting in the necessary charge. But this is slow, if it is simply to remove the boulder. The second way is by bull-dosing. This is done by placing several sticks of dynamite on top of the boulder on the flattest part near the centre, and covering with fine moist clay to exclude the air. But this is very expensive as to powder. The third way is to dig a hole with a bar under the boulder, and always try to get the charge under the concave part near the centre and never on the round or bulge side. This is the cheapest and best method.

Hardpan.—In blasting hardpan drill holes horizontally into the bank about eight to ten feet apart and six to seven feet deep, with bars or spoon shovel for the purpose. These holes can be sprung by a high explosive to make room for the charge, about one stick of 60 per cent. dynamite is sufficient for the first time. This gives you an idea how it will work and what powder you may require to get a pot-hole sufficiently large enough to receive the full charge. Be careful not to reload before all chance of fire from the fuse has gone and in springing use no tamping, as confining the charge will break the wall of the bore hole. After springing and before placing the final charge, clean the hole well out, removing all loose material with the spoon shovel. Then load according to what you want done. This has been found a very successful way.

Holes can be widened in hardpan in the following way: Drive your bar-drill to above twelve to fifteen inches into the bank, then use a primer, of about one-third or half a stick of 40 per cent. dynamite, according to solidity of material, clean out and repeat, driving the bar or drill twelve inches further and charging again, and so on. Six feet is about the distance most successfully done in this manner, and the hole is anything from three to five inches wide.

This method suits best where two men are working, but in case of a whole crew with horses, etc., causes the others to lose more time than anything gained. However, a good foreman can easily regulate this. Do not use a high explosive for the final charge, as it is too quick, and therefore local. It is better to use black powder, which is slower in action, or Judson powder of low grade. Judson powder is highly recommended for that particular, because it is almost as slow as black powder and has double the power.

Blasting Stumps.—In blasting stumps, take your bar and spoon shovel and drill a hole under the stump and close to the main root. If the stump is large, you may have to spring the hole to make room for the charge. After charging, tamp well. In wet ground be careful about greasing your primer and see that you use waterproof fuse. Water makes good tamping for dynamite, but not for black powder, excluding the air, but you must see that it comes up to the surface level at the stump. If the stumps are in very soft ground, it will be deemed advisable to place a flat rock

under the stump to place the charge on. If the earth is free from rocks, the hole may be drilled with an earth auger. If large stumps show signs of rottenness in the centre, place your charge under the most solid part, and in cases where they burst open, leaving parts of the stump and roots still in the ground, which have afterwards to be dug out, try a heavy chain fixed tightly round the upper part of the stump, about twelve inches or so from the ground. This is sometimes very successful, but depends on the powderman and the judging of his shots.

Mixing Powders.—Never use two qualities of powder in the same drill hole or charge, as it does not seem to be any great benefit. Dynamite will set off black powder, but it is so quick in its action that it may do considerable damage before the total ignition of the black powder takes place, making fractures, which allow the gases of the latter to escape, thus reducing its power. However, it is very effective in cases where a number of holes have to be tried, to load one with dynamite and the other with gunpowder or Judson powder, and so on, and firing with battery.

The magneto machine is one of the best, and be sure you get it strong enough to set off as many shots at one time as you require.

The cable used to connect up the wire fuses and the magneto machine should be strong, well insulated and pliable. A reel should be used for winding it up immediately after use.

Explosives will keep a considerable time if well stored, but one should be careful not to order more than he expects to use during the season. Explosives should not be mixed in a magazine nor should caps or detonators be stored with powder.

In handling dynamite do not throw it violently from your shoulder, nor smash the box open with an axe or hammer, or in any other violent way, particularly if the weather is hot; nor should it be packed too high one on another, in the magazine. In hot weather do not carry a box of dynamite on your head or shoulder, over rough ground, in case of stumbling. Black powder in kegs is loose, and weighs twenty-five or fifty pounds in boxes, compressed in cartridges. Do not smash a keg or box open with any iron or steel tool; wood or copper should only be used.

Magazine.—A magazine should be built much the same as a root house, frost proof, if possible, good drainage, well back from any settlement or highway or heavy timber, and according to the Explosive Regulations of this Province, chapter 80, paragraph 4, all the ironwork in the inside should be covered, or nails driven down below the surface of the boards and puttied. The hinges should be copper, also the lock and key. The floor should not be rough or rocky; it should be of earth, but better still, wood free from any iron or steel. Brick, concrete or stone is dangerous. Bitumen is one of the best. A lightning conductor should be put on outside and be well grounded away from the magazine.

TEMISKAMING AND NORTHERN ONTARIO RAILWAY.

We publish below statistics of the operation of the T. & N. O. Railway, which is managed through a commission appointed by the Ontario Government. There is a slight decrease in the total revenue for 1912, and a slight increase in the corresponding year's expenditures. The reduction in revenue from operation is due mainly to the Cobalt mining camps' increased use of mills for concentration of their ore values and a consequent great reduction in tonnage of ore shipped out. The use of electric energy for power purposes is also reducing to a great extent the transport of coal to the north country.

FROM 1905 TO 1912, INCLUSIVE.

Year.	Freight.	Passenger.	Other Revenue.	Maintenance of Way and Structures.	Maintenance of Equipment.	Traffic Expenses.	Transportation Expenses.	General Expenses.	Total Revenue.	Total Expenditure.
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
1905.........	121,530 46	108,681 76	23,508 33	25,072 89	12,533 68	....	88,342 41	13,823 52	253,720 55	139,772 50
1906.........	230,552 63	254,759 33	58,706 89	77,265 87	46,382 65	....	215,256 08	23,587 98	544,018 85	362,492 58
1907.........	390,894 29	388,343 03	74,282 69	112,395 22	88,016 79	....	412,160 52	32,839 76	853,520 01	645,412 29
1908.........	471,203 41	366,504 53	135,357 67	125,563 43	119,563 01	9,789 99	405,907 58	24,863 45	973,065 61	688,397 43
1909 (10 mos.)	756,141 66	483,110 89	121,972 32	191,170 18	107,078 96	14,920 04	436,768 41	49,989 34	1,361,224 87	794,796 88
1910.........	852,886 46	666,967 91	131,997 65	380,314 75	137,340 46	17,705 31	556,740 45	76,045 66	1,591,852 02	1,165,361 26
1911.........	974,678 33	653,063 01	153,223 49	353,918 92	164,145 69	17,461 22	567,316 97	78,911 74	1,780,964 83	1,181,998 63
1912.........	929,464 66	599,681 73	178,303 68	346,964 61	249,683 22	12,499 96	676,963 33	93,625 91	1,707,450 07	1,384,697 69
	4,727,351 90	3,461,112 10	877,352 72	1,612,665 27	924,744 46	72,736 52	3,359,455 75	393,687 36	9,065,816 81	6,362,929 36

Temiskaming and Northern Ontario Railway Statement.

Summary.

Freight revenue	$4,727,351.90
Passenger revenue	3,461,112.10
Other revenue	877,352.72
	$9,065,816.81
Earnings—Ore Royalties, etc.	473,643.74
Balance at profit and loss.....	$ 338,286.03

Maintenance of ways and structures	$1,612,665.27
Maintenance of equipment	924,744.46
Transportation expenses	3,359,455.75
Traffic expenses	72,376.52
General expenses	393,687.36
Total expenditure	$6,362,929.36
Paid treasurer of Ontario.........	2,838,245.16

COFFERDAM CONSTRUCTION.

In a paper published by the American Society of Civil Engineers, Volume XXXIX., entitled, "Fremantle Graving Dock: Steel Dam Construction for North Wall," J. F. Ramsbotham describes the construction of a cofferdam in Australia for a submerged depth of over 50 feet. If, after excavation, a doubtful foundation was disclosed the site for the graving dock was to be changed and a quay wall built. The following is an abstract from the paper:

Steel sheet piling was used and the material in which the piles were driven consisted of a hard limestone cap, coral, clay, and sandstone, the limestone cap being particularly hard in a portion of the pumping station, where a total of 60 ft. of driving had to be done, or, in other words, each pile had to be driven 60 ft. into the ground. It is worthy of record that, in driving one of the steel piles, a 45-lbs.per-yd. steel rail was cut into two pieces, one section being found subsequently on excavating within the dam.

From a driving point of view, these piles are admirable, as the cross-sectional area, or displacement, is small compared with the covering area of the face of the pile. Although whippy, with care very few piles were damaged; and, further in shipping 1,900 piles, 60 ft. long, from the United States to Western Australia, not one was damaged, and only two were damaged in handling for driving. In handling from the steamer it was found best to have 8 x 3½-in. fish-plates of Oregon pine, 10 ft. long, with a sling chain around them, placed 20 ft. from one end. In handling, preparatory to driving, a single piece of 7 x 3-in. Oregon pine, 8 ft. long, was found best, and was slung one-third from one end.

Design of Dam.—The points that require careful watching in designing a dam are: (1) Strength of skin (which can be taken as a beam supported at several points, and to an extent this is advantageous, as benefit is derived from contraflexure); (2) strength of walings or longitudinal beams; (3) strength of shores or transverse columns; and (4) factor of safety on the dam.

Great benefit may be derived from working in water, as it is possible to calculate exactly the loads which the various members of the structure have to carry; and, needless to say, the object is to place the walings and shores so that they and also the skin will have an ample factor of safety.

In designing the dam, a maximum tide of 6 ft. 6 ins. above low-water mark was considered, and the dredged bottom was taken at 49 ft. below low-water mark, thus giving a total calculated head of 55 ft. 6 ins., which in actual work could be taken at 51 ft. Further, clay puddle was tipped to a minimum height of 9 ft. at the skin of the dam, in order to make a seal of the porous rock, and at the same time, reduce considerably the head on the dam. Assuming that the shores are placed at 10-ft. centres horizontally, the pressure on a strip of dam, 10 ft. wide is:

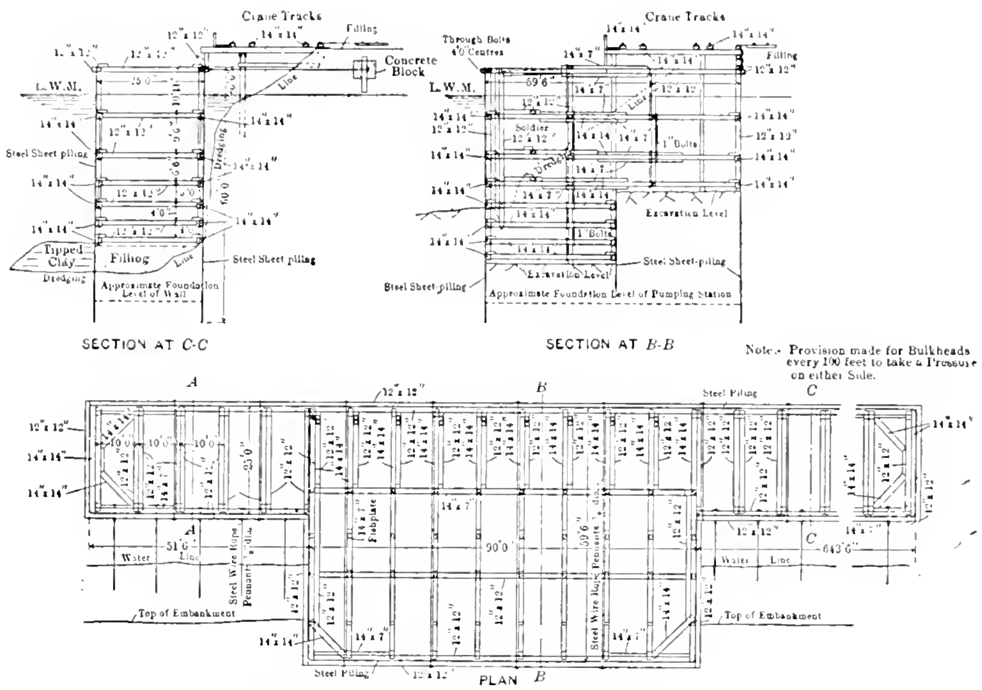
$$\frac{55 \text{ ft. } 6 \text{ ins.} \times 10 \times 55 \text{ ft. } 6 \text{ ins.} \times 64}{2 \times 2{,}240} = 440 \text{ tons}$$

The strength of a jarrah beam, loaded uniformly and supported at each end, is given by the following formula, in which K is a constant which has been ascertained to be 13; B is the breadth, and is assumed to be 14 ins.; D is the depth, and is assumed to be 14 ins.; and L is the length which is 9 ft., or 108 ins.:

Breaking weight, in hundredweights =

$$\frac{8\,K\,B\,D^2}{L} = \frac{8 \times 13 \times 14 \times 14 \times 14}{108} = 2{,}642 \text{ cwt.} = 132 \text{ tons.}$$

Thus, using a factor of safety of 3, the safe load $= \dfrac{132}{3}$ = 44 tons. From this the number of walings or beams required is $\dfrac{440}{44} = 10$.



Plan and Section of Cofferdam.

It is worthy of note that, in calculating the strength of walings, no allowance was made for the fact that the beams were continuous over several supports, thus giving a greater margin of safety than is shown. The shores or columns were 12 ins. square and 22 ft. 8 ins. long, and were worked out by Gordon's formula in a similar manner, one end being considered rounded and the other fixed, the factor of safety being slightly less than 3.

When the driving of the piles was completed, it was found that it was impracticable to keep them absolutely vertical or in line, due to the hard nature of the ground; and, although the divers packed between all piles and the back of the walings, a certain amount of unquestionable bridging or arching took place. This was so marked that, without any further delay, additional shores were placed alongside those already in, the factor of safety of the walings thus being increased to 3¾ and the shores to almost 4½.

The skin of the dam is important, and the largest span was settled empirically from observations and was a clear span of 8 ft. 8 ins., subjected to an actual head of 17 ft. 7

ins. of water. In the dam in question, the span was 8 ft. 7 ins. between the second and third shores. Between the first and second shores the clear span is 9 ft. 11 ins., and, although allowance was made for a high tide of 6 ft. 6 ins., it is seldom if ever reached. From the writer's experience, a clear span of 8 ft. 8 ins., subjected to a mean head of 10 ft. 8 ins., is quite satisfactory, the total load on a pile being 4.88 tons, and the maximum stress about 10 tons per sq. in.

Practical Construction Details.—First, it is of the utmost importance that the female end of the pile should always be driven over the male, and not the male in the female. If the latter is done, a column of spoil will be compressed under the male in the jaws of the female which will finally end in the bursting of the structure. To enable rapid progress two piles were split down the centre and a double male pile manufactured, riveting a 6 x 3 x ½-in. **T**-iron on the back for stiffness. By this means two piling machines were utilized; one was built on an outrigger, with one end supported on staging and the other end on a log on the ground, the piling frame, winch, boiler, etc., being self-contained and easily moved. The other machine was on a barge, and was also self-contained.

In passing, it may be mentioned that the piling winches were made by the Lidgerwood Manufacturing Company, and were capable of working a 2-ton "tup" or hammer. A 30-cwt. tup was found to be best in practice, and a good man can get 20 blows per minute, a 5-ft. drop being quite sufficient. From the plan it will be noticed that provisions were made for subdividing the dam every 100 ft. by using **T**-piles, a male and female **T**-pile being left opposite each other; this was done in accordance with the catalogue of the makers of the piling. When the time came to drive, however, difficulties arose, and as they could be overcome very easily by the manufacturers of the piles, the writer mentions them, hoping that he may thus assist others.

First.—By having a female **T**-pile, it would mean, in the ordinary course, driving a male pile in it; as previously mentioned, if this is done, it will end in disaster, unless the spoil in which it is driven is a fluid mud. To overcome this, a double female pile was made, and on one side a strip of iron, 1 in. wide and ½ in. thick, was tapped on the outside on one jaw in order to make a lock. The jaws were then interlocked, and the pile was driven, there being clearance for any displacement of spoil between the jaws.

Second.—Great care must be exercised in keeping the two **T**-piles parallel, otherwise obvious difficulties will arise in closing. The manufacturers could overcome this by making an expanding pile with slotted holes, so as to enable the closing pile to vary its width from the top to the bottom.

Third.—Even with parallel piles, it is extremely hard to marry in with the closing pile, and it is desirable to have a few piles of different width.

Fourth.—If a male **T**-pile is used at each side of the dam, as should be done, a double female pile is required with which to end, and such should be supplied by the manufacturers.

Fifth.—If a male **T**-pile is urgently required, it can easily be made, and at small cost, by riveting an ordinary 45-lb. rail to an ordinary pile.

Sixth.—In driving the piles, the moment one seems to be hardening up and has not reached the required depth, another should be driven ahead of it, and, if necessary, this should be repeated until there are signs of having reached soft ground again. It is then possible to exert more force, but even then abuse must not be resorted to, as there is grave danger of parting the piles, but if this does happen by having driven ahead, that danger is limited in extent and is only local.

From the cross-section it will be noted that the piles toward the shore were driven on the side of a cliff, which had been left in a very irregular condition by the dredging, and added considerably to the difficulties of the piling gang; it also rather retarded the progress, as some piles had to be drawn. A fair month's work for the two machines, there being two 8-hour shifts on each machine, averaged 370 piles, representing 9,361 lin. ft. of driving.

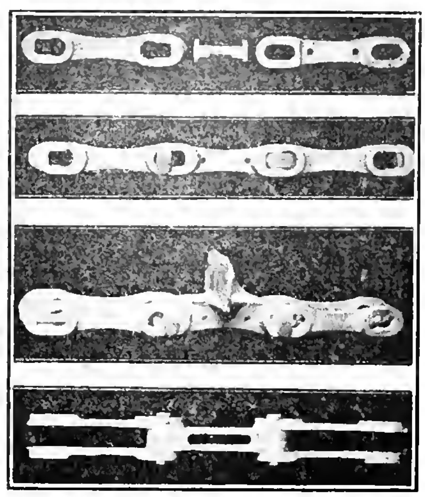
The first steel pile was driven on July 14, and pumping was started in Dam Section No. 1 on November 16, the entire dam being framed by the end of the year.

It is interesting to note that 1,872 steel piles were used, representing 47,385 lin. ft., or 9 miles of actual driving. In the first dam section there were 401 piles, which gives 24,060 lin. ft. of joint, representing very nearly 5 miles of joint.

A RIVETLESS CHAIN.

A chain was recently patented by Joseph L. Lee, general superintendent of the Cross Engineering Company, Carbondale, Pennsylvania, and manufacturing and selling arrangements have been entered into with the company, which is preparing to market the chain at an early date. The principle of this chain is entirely new, but simple, from which it derives its trade name of "Simplex." The accompanying illustrations of links, pins, attachments, and assembled parts are to a large extent self-explanatory, but the following claims are made for this new product by the inventor and manufacturers:—

This chain is interchangeable in all parts. Its parts are easily and quickly detachable, and each section can be so detached in less than a minute. The links can be released or removed by a horizontal movement of the diameter of the pin, or in the 9-in. pitch, 1⅛-in. movement, doing away with the necessity of adjustment of take-up when links or pins require renewal, or to reverse the pins for further service. It will operate over either a sprocket wheel or a traction wheel by reason of the concave shape of the links, and is also interchangeable with certain other types of rivetless chain. The chain has a wearing surface on both link and pin equivalent to standard riveted eye-bar chain, generally known as the 'Scranton' type of chain, the pins being reversible, so that after becoming worn on one side they can be reversed 180°, so presenting the unworn side for 100% additional service, and at the same time nearly restoring the chain to its original pitch.



A special feature of this chain, as well as a distinct advantage over any other type of chain, is the "lip" shown on the outside links. When the chain is in working position, and whether in the position of passing over a sprocket or

traction wheel, the double-slot space back of the pins on the centre links, forming a recess or pocket, is entirely closed. This prevents dirt or gritty material from coming in contact with the wearing surfaces, and if desired the recess or pocket may be filled with any solid lubricant, such as graphite or hard grease, and so insure the longest possible life to both link and pin at the contact points of wear and friction.

The links, being solid, have a distinct advantage over the web, or open, type of link, as there is no compression at any point on either link or pin to cause the chain parts or attachments to stick or to be disconnected with difficulty, and it is not necessary to remove the attachments to disconnect the links or pins.

The two centre links form a pocket for the insertion of the several forms of attachments required, and may be reversed "back to back" and so used for attachments requiring side elevation or conveyance. Attachments for this chain will first be made of malleable iron to meet standard elevating and conveying requirements, and for extraordinary service certain attachments will later be made of a special tough steel. Attachments when bolted to links will, it is claimed, bear an equivalent strain as if cast in one piece. The links are to be drop-forged from 30 to 40-point carbon steel and broached to assemble to accurate pitch, and the pins are also to be drop-forged and machine-finished, and to be shop-assembled to links to insure the free working of chain parts.

It is the claim of the manufacturer that this chain will in a large measure displace several of the types of riveted chain now in use. The Cross Engineering Company is preparing to manufacture this chain in 4-in., 6-in. and 9-in. pitch, and it is stated that the chain will be sold at no general increase in price over the standard type of drop-forged, riveted bar chain. It is the general claim that Simplex rivetless chain is more simple to assemble and disconnect than any other type of rivetless chain now in use, and that it is as easily detached as the Ewart type of detachable chain or belting.

SHORT METHOD OF COMPUTING AREA OF CIRCULAR SEGMENT.

By J. A. Macdonald.

To find the area of a circular segment: Find the area of the sector that has the same arc as the segment; find also the area of the triangle, whose vortex is the centre, and whose base is the chord of the segment; there the area of the segment is the difference or sum of these two areas, according as the segment is less or greater than a semicircle.

The chord and height of a segment are = 24 and 6; find its area.

$$\tan \tfrac{1}{4} n = \frac{2h}{c} = \frac{12}{24} = .5 = \tan 26^\circ\ 33'\ 54'' \text{ and hence}$$

$$n = 106^\circ\ 15'\ 36'' = 106^\circ.26.$$

$$2r - h = \frac{c^2}{4h} = \frac{144}{6} = 24, \text{ and } r = 15.$$

Then sector $= .008727\ n\, r^2 = .008727 \times 106.26 \times 225 = 208.64$;

also, triangle $= \tfrac{1}{2}\, c P = \tfrac{1}{2} \times 24 \times 9 = 108$;

hence, segment = sector — triangle = 208.64 — 108 = 100.64.

This is the usual method of obtaining these quantities. It involves the computation of the radius, the central angle, the area of the sector, and the corresponding triangle, and the difference between the sector and the triangle equals the area of the segment.

Trautwine gives a table of areas of segments, but, when the chord and mid-ordinate alone are known, as is frequently the case, the use of this table consumes considerable time. The diameter must first of all be obtained by the formula:—

$$D = \frac{s^2}{4r} + r,$$

in which D is the diameter, s the chord, and r the mid-ordinate. The mid ordinate must then be divided by the diameter. The table gives for this ratio a factor which must be multiplied by the square of the diameter to obtain the area of the segment.

In the handbook of the "Verein Hutte" there is a table of lengths of arcs, mid-ordinates, chord lengths and areas of segments for circles of unit radius corresponding to any central angle. In order to use this table it is, therefore, necessary to compute the radius and the central angle from the chord.

For facility of computation two tables have been prepared, one for areas of segments and the other for lengths of arcs. In one column the ratio of the mid-ordinate to the chord is given, and in the adjacent column the corresponding value of c. To obtain the area of the segment, the product of the mid ordinate and the chord is to be multiplied by c, obtained from the table. More time is saved by the use of the table of areas of segments, and this table is, therefore, given.

Areas of segments of circles:—

Span or chord = s.
Rise or mid-ordinate = r.
Area = c r s.

r/s.	c.	r/s.	c.	r/s.	c.
0.01	0.6667	0.18	0.6836	0.35	0.7280
.02	.6669	.19	.6855	.36	.7313
.03	.6671	.20	.6875	.37	.7347
.04	.6675	.21	.6896	.38	.7382
.05	.6680	.22	.6918	.39	.7418
.06	.6686	.23	.6941	.40	.7455
.07	.6693	.24	.6965	.41	.7493
.08	.6701	.25	.6989	.42	.7531
.09	.6710	.26	.7014	.43	.7569
.10	.6720	.27	.7040	.44	.7608
.11	.6731	.28	.7067	.45	.7648
.12	.6743	.29	.7095	.46	.7688
.13	.6756	.30	.7124	.47	.7729
.14	.6770	.31	.7154	.48	.7770
.15	.6785	.32	.7185	.49	.7812
.16	.6801	.33	.7216	.50	.7854
.17	.6818	.34	.7248		

As an illustration of its use the area of the segment being a chord of 3.9634 feet and a mid-ordinate of 1.5 ft. is computed.

s = 3.9634 ft.	r = 1.5 ft.
r/s = 0.3785	log. = 9.578023
r = 1.5	log. = 0.176091
s = 3.9634	log. = 0.598068
c = 0.7377	log. = 9.867880
Area = 4.386 sq. ft.	log. = 0.642039

The Canadian Contracting and Construction Company have opened offices at the McKinnon Building, Toronto, and at Brandon, Manitoba. The managing director is C. G. Gillespie, of Toronto.

COMPARISONS OF COST OF WOOD AND STEEL FENCE POSTS FOR RAILWAYS.*

Wood Posts.—The life of wood posts of various kinds actually in use is as follows:—

Life of Posts.

	Years.
Red Cedar	7 to 25
Cedar	10 to 30
White Cedar	12 to 17
Chestnut	10 to 15
Locust	7 to 20
Yellow Locust	15 to 30
Black Locust	10 to 25
White Oak	7 to 15

Doubtless some give little heed to the particular species of the timber that they use, and assume that any species of that genius has about the same life. This is manifestly incorrect as is demonstrated by the oak family. The inferior grades of oak have a life only of from 2 to 4 years, while a good white oak has a life in our northern climates of from 10 to 12 years at least. Certain classes of oak last much longer in their native regions than in other localities to which they are transported for use. This principle applies with equal force to every other class of timber.

In reviewing the replies of the various roads we find that the consensus of opinion, based upon experience of the users, is that the different classes of timber have an average life as indicated below:—

	Years.
Red Cedar	18
White Cedar	15
Chestnut	12
Yellow Locust	20
Black Locust	20
White Oak	10

Climatic influences have an important bearing upon this phase of the case, and may lengthen or shorten the life of a particular kind of wood, dependent upon locality in which used.

From information received, the cost of the various kinds of wood posts is:—

	Range.	Average.
Red Cedar	15c. to 25c.	22c.
Cedar	7c. to 20c.	14c.
White Cedar	12c. to 15c.	14c.
Chestnut	10c. to 27c.	20c.
Locust	15c. to 40c.	25c.
Yellow Locust	20c. to 38c.	30c.
Black Locust	15c. to 25c.	20c.
White Oak	11c. to 40c.	20c.

It was of interest to know to what extent wooden posts were subject to destruction by fire. Replies received indicated that this varied by from 1 per cent. to 5 per cent., with the exception of one road which reported a loss of 30 per cent. from this cause. We think it fair to assume that the average loss by fire is around 3 per cent.

Steel Posts.—Only two roads so far as we can learn make mention of having used any metal posts, and then but to a limited extent. In the one case bar iron ¼ x 2 inches was used and in the other old boiler tubes. We have reason to believe, however, that quite a number of roads, not replying to our circular, are trying out a proprietary metal post. Several styles of steel right-of-way fence posts are on the market. Their exploitation has just begun in the last year or two, and any statement as to their efficiency and economy could be but vague and from the manufacturers' standpoint alone. Greater experience may demonstrate their utility, but thus far we have no data upon them, and can only give some computations from one of the manufacturers, which might be of interest for study from the viewpoint of railroad economy. These figures, while prepared for a certain style of post only, if reliable, will no doubt be equally accurate for any other style of metal post, built along similar lines, and others are generally so designed.

Steel posts cost	23.03 cents
Cost of setting	1.30 cents
Total	24.33 cents
Estimated life	30 years

Based upon above figures, steel posts set one rod apart cost 81 cents per year.

The cost of setting wood posts is estimated at 5.8 cents each. The following table is based on wood posts costing from nothing up to 20 cents each, and is intended to show what the life of wood posts must be at different first costs to be as cheap as the steel posts:—

Cost of post. Cents.	Cost of setting. Cents.	Total cost. Cents.	Years it must last to be as cheap as steel. Years.
0	5.8	5.8	7.1
5	5.8	10.8	13.3
8	5.8	13.8	17.
10	5.8	15.8	19.5
12	5.8	17.8	21.9
15	5.8	20.8	25.6
17	5.8	22.8	28.1
18.53	5.8	24.33	30.
20	5.8	25.8	31.8

The above figures would indicate that wood posts costing 15 cents would have to have a life of 25.6 years and those costing 20 cents a life of 31.8 years to be as cheap as steel.

The first steel posts are said to have been manufactured about 15 years ago at Bloomfield, Ind. Others, doubtless, of different design unknown to the committee were manufactured as long ago and perhaps longer, but only during the past twelve years have they been given any serious study with a view to placing them on the market for ordinary right-of-way fencing. Hundreds were taken up and examined to discover signs of rust and deterioration at ground line or elsewhere. They have been in use at Spencer, Worthington, Bloomfield, Ind., and elsewhere in all kinds of soil and under all conditions. The investigations have resulted in placing them on the market during the past year or so.

To be of economic worth for right-of-way protection, a fence post must possess the following qualities: Durability, practicability, efficiency and the price must be right. Inquiry develops that one man can set in a day from 15 to 35 wooden line posts. To be conservative, 30 posts per day per man is assumed as the unit of work. Estimating wages at $1.75 per day places the cost of setting a wood post at 5.8 cents. The cost of post is estimated at 12 cents, resulting in an entire outlay of 17.8 cents. Experience is to have demonstrated that three men can readily set from 390 to 640 steel posts per day, or 130 to 213 per man—130 posts per man is taken as the basis of calculation with wages at $1.75 per day. This places the cost for setting a steel post at 1.3 cents. Cost of steel post 23.03 cents, plus cost of setting 1.3 cents, resulting in entire outlay, 24.33 cents.

* Abstract of report of a committee of the American Railway Engineering Association.

Comparative Cost of Steel and Wood.

Entire cost of steel post, 24.33 cts., estimated life 30 years
Money worth 6 per cent.
Entire cost of wood post, 17.80 cts.; estimated life 12 years
Expenditure for steel posts ....24.33 cents
Expenditure for wood posts ....17.80 cents

Difference .... 6.26 cents

Compound interest on 6.26 cents for 12 years amounts to 13.06 cents. At the expiration of 12 years wood posts have failed and need renewal. 13.06 cents has been saved over cost of steel posts. This is equivalent to purchasing 8.8 years more protection with wood. In other words, 24.33 cents expended for steel gives 30 years of protection, while same amount expended for wood gives 12 years original life, plus 8.8 years' interest on investment, or 20.8 years, a balance in favor of steel of 9.2 years. Viewing the matter from another angle, assuming that posts are set one rod apart, track protection costs per year as follows:—

Steel Posts—

Per rod	$	.0081
Per mile		2.59
Per 100 miles		259.00

Wood Posts—

Per rod	$	.0117
Per mile		3.74
Per 100 miles		374.00

Balance in favor of steel posts of—

$ .0036 per rod per year.
1.15 per mile per year.
115.00 per 100 miles per year.

Other advantages claimed are no staples used; right-of-way may be burned over from time to time without injury to posts. No loss from accidental fires and no renewal on that account. Special end, corner and gate posts must be used in connection with the steel line posts. No means are provided for bracing them so as to use them as end or corner posts. There is not enough steel in them to stand the strain of stretching a heavy wire fence. The minimum amount of steel is used necessary to meet requirements of a right-of-way fence. The line and end posts are treated as distinct problems. In this they are not unlike posts made of other materials. The demands on the end and corner posts are entirely different from those on the line posts. The line post should possess a certain degree of flexibility, while end and corner posts must be absolutely rigid. The following is the comparative cost of steel and wood end and corner posts:—

Cost of end post $1.62
Cost of corner post 2.30

Assuming it fair to say that twice as many end posts will be needed as corner posts, it places the average of the stretching post at $1.84 each. If $1.84, the cost of the steel corner post, bears the same relation to the cost of a good wooden corner post that the price of the steel line post bears to the price of the wooden post, then the economy is demonstrated. In order to determine whether or not this relation maintains, we resort to the following equation:—

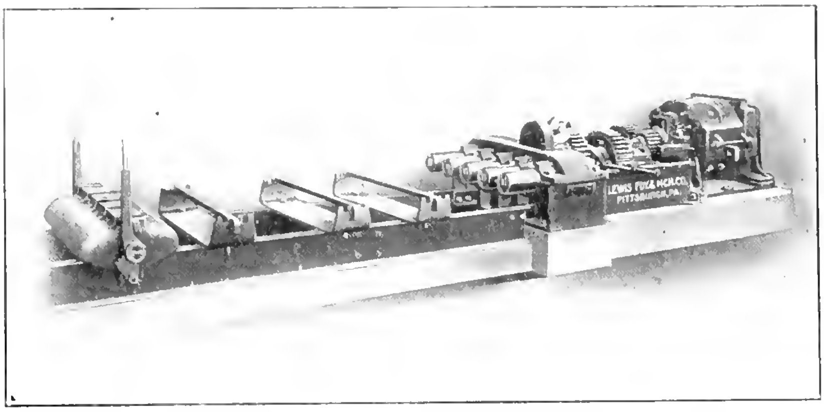
$$\frac{12c.\ \text{(cost of wood line post)}}{23.03c.\ \text{(cost of steel line post)}} = \frac{x\ \text{(cost of wood corner post)}}{\$1.84\ \text{(cost of steel corner post)}}$$

We find $x = 96$ cents, cost of wooden corner post, which appears to be a conservative estimate of the cost of a good wooden corner post. From a mathematical and perspective point of view, the manufacturer of the steel fence post appears to have made out a case that is worthy of continued and further close investigation. Time alone, under practical service conditions, can demonstrate if the figures are based upon substantial premises.

The steel fence post has not yet proved its merit in practice and at this time concrete with suitable reinforcement seems to offer the only solution to the problem.

MOTOR-OPERATED BAR-TWISTER.

In concrete work the steel bar gives the tensile and the concrete the compression strength. In order to produce a bar having a high elastic limit and homogeneous texture, it is essential that continuous and uniform running be attained on the machine used in twisting these steel sections. A great deal of trouble is experienced with belt-driven machines on account of belt slippage causing unnecessary strain during the twisting process, which usually results in an inferior product due to the elastic limit of the bar being exceeded. With a motor gear-connected to the machine, as shown in the accompanying illustration, an occurrence of this kind is practically impossible, since this method of motor connection insures constant torque being applied during the time the bars are being twisted.



The type of machine here shown, manufactured by Lewis Foundry and Machine Company, which is used for twisting Ransom bars, is arranged for two speeds. A 75-h.p. Westinghouse mill motor is used on five 1¼-inch bars, and a 60-h.p. motor on five 1⅛-inch bars. The twisting heads are steel castings arranged to receive tool steel dies for bars ⅜-inch to 1¼-inch, advancing by eighths of an inch. Bearings are brass bushed, and the shafts turned and hammered open-hearth steel. The bed is made of 10-inch channels of sufficient length to accommodate 60-foot bars. The tail-stock is so arranged that is may be locked on bed at any distance from head stock. An index is provided to register the number of turns made by the bar-twisting head. The dial is reset by hand, and can be moved back to zero when the load is released. The twisting speed of the head is about 60 r.p.m. for 1¼-inch bars, taking about one minute. The time consumed in loading and unloading is about two minutes; consequently, a complete cycle occurs every three minutes. One complete standard twist will occur on 1¼-inch bars in 12½ inches, and on 1-inch bars in 10 inches.

COAST TO COAST.

Vancouver, B.C.—Mr. H. M. Davy, engineer in charge of test borings for the public works department, Ottawa, has completed his work here of securing full data of Victoria and Vancouver harbors. Test borings were made along the south and north shores of Burrard Inlet with the object of locating sites for the proposed government wharves, and for other wharves and docks which may be erected here later on by the Dominion Government. Borings were made in False Creek in order to secure data for the amount of dredging which would be required, and to learn the class of materials which will have to be removed. The contract for this work has already been awarded to the Pacific Dredging Company, Limited. In Victoria a great many borings were made to secure information necessary for the proposed improvements to the inner harbor, and also for the proposed wharves for the outer harbor. The work in Victoria was frequently delayed by rough weather, but no delay was caused here, owing to the harbor being practically landlocked.

Montreal, Que.—An extensive programme of harbor improvements for the coming season, mapped out by the harbor commissioners, marks a new era in the history of the port of Montreal. The guard pier will be completed, and the south side described on the maps as the east wall quay embankment, will be continued to effect the backing up of the great volume of water below Victoria pier, across the channel in the direction of Moffat's Island, thus diminishing the velocity of the St. Lawrence current. The estimated cost of these improvements exceeds $2,000,000. A great portion of the material to be used in the erection of breakwaters, piers, etc., will be procured from the Mount Royal tunnel. Already great quantities of the solid rock are being shipped from back of the mountain to the water-front by the Canadian Northern Railway. Another improvement to be completed is the ballasting of the high level tracks which have been laid down from Victoria pier to the Racine pier. These will be trimmed and made permanent.

Victoria, B.C.—A deputation consisting of members of the Board of Trade and City Council will go to Ottawa to interview the Dominion Government upon the necessity of making immediate and adequate provision for the handling of large vessels at the outer wharf. In a recent letter to the City Council Mr. E. J. M. Nash, the special representative of the Royal Mail Steam Packet Company, which concern has four 20,000-ton vessels on order at Belfast to be ready to break into the service of this coast immediately the Panama Canal is completed, pointed out that the present facilities at Victoria, both as regards handling the traffic of such vessels, and as regards having them repaired in the event of an injury, were utterly inadequate; and that if Victoria desired to take her proper place as an ocean port it was up to her not only to extend her wharf accommodation in a greater ratio than has even been contemplated so far, but to at once make a start upon the construction of a large drydock.

Toronto, Ont.—A unique collection of model roadways in miniature is now on exhibition in the Parliament Buildings for the education of the general public in the secrets of highway construction in the province. Stretched upon a frame along with others dating from time immemorial and composed of bits of the stone and material of the actual construction, is a replica of the old Appian way as it came from the hands of the ancient Roman builders. There is also the model of an old French road constructed previous to the year 1775, following upon the Roman style of stone laying. It is composed of two layers, the foundation being formed of broad flat stones cleverly jointed by hand and the interstices filled with carefully ground pebbles. The next design in the evolution of the modern highway advocated the laying of the stones on the edges and in this way the wearing capacity was hugely increased and the drainage made more simple. The English Telford road followed, with a stone base laid entirely by hand and a curved surface. The old macadamized road which proved the most efficient of all for increasing road traffic is shown subject to the improvements which the highways department of Ontario has instituted in the substitution of three layers for one to withstand the wear and tear of heavy automobile driving. An exhibit of peculiar interest is that of a bituminous asphalt or tar highway comprising in all six layers of a most durable nature, and intended especially for pleasure drives where power machines are in constant use. This road the Ontario Government will experiment with to some extent during the year, and it is hoped will prove it so successful that actual construction will be undertaken. The display is under the care of Provincial Engineer of Highways W. A. McLean, and has been obtained from the public roads department of the United States Government.

Kingston, Ont.—The first step towards the cleaning up of the waterways of the province in accord with the recommendations of the recent convention of the International Waterways Commission has been taken, under the direction of the provincial board of health here. Owing to certain local conditions which are considered to be especially suited for experimentation by the board, F. A. Dallyn, provincial sanitary engineer, with a staff of assistants, has begun operations in the line of water investigation. A laboratory has been opened in Clarence Chambers and a launch has been chartered. Tests will be made from here down through the islands and for a space around the city. The investigation is made under the co-operative management of the Ontario and United States authorities, Dr. McLaughlin, an American expert, working jointly with F. A. Dallyn, provincial sanitary engineer. The working staff employed in that direction, it is understood, will be supplemented by a number of advanced science students now studying at Toronto University.

New Westminster, B.C.—In addition to the three million dollars which the Canadian Northern Railway will spend in improvements at Port Mann, an equal amount will be expended in New Westminster. According to recent despatches, Sir William Mackenzie and Col. Davidson, who are at present in London, are finding no difficulty in obtaining money for the project. Definite appropriations have been made for extending the railway through the city to the North Arm Bridge, and for the Port Mann improvements. This sum will be expended on elevated tracks, terminal yards on the Royal Mill site, trackage on the Trapp ranch and on the North Arm bridge, to connect with the Lulu Island line to Steveston. It is planned to start the Port Mann construction prior to the commencement of the local improvements, and it is stated that the contractors will have the work at the former place under way within a month. This work consists of filling in, the construction and equipment of machine and repair shops, boiler works, roundhouses and other terminal buildings. About twenty miles of storage and sorting tracks will be provided as a first unit.

Ottawa, Ont.—Mr. L. J. Burpee, secretary of the Canadian section of the International Waterways Commission, in a recent interview, said in regard to certain reports from Washington as to the abolition of the organization, they were evidently based on a misconception of the status of the international joint commission. "Neither Congress nor the

Imperial or Dominion Parliament," he said, "has any power to abolish the commission that constitutes that tribunal. Three were appointed by the President of the United States and three by the King on the recommendation of the Governor-in-Council of Canada—that is, practically on the recommendation of the Canadian Government. They were appointed under terms of the Waterways Treaty, which was signed in 1909 and ratified in 1910, and one of its provisions is that the treaty shall remain in force for five years from the exchange of ratifications and thereafter until terminated by twelve months' notice by one or other of the high contracting parties. The treaty, therefore, remains in force at least until the year 1916, and the commission, which is an essential development of the treaty, also remains in existence until that year at least. The personnel of the commission, the individual members, may, of course, be changed at any time by the National authorities by whom they were appointed; but the commission itself rests upon the foundation of a solemn treaty entered into by the two countries and cannot be put out of existence until the treaty itself comes to an end."

Toronto, Ont.—A deputation from the district between St. Thomas and Windsor, representing all the cities and the municipalities, waited on Hon. Adam Beck and the Hydro-Electric Commission at the Parliament Buildings recently and advocated the southern route as near to the lake as possible as the most advantageous one for the route of the proposed transmission line that is to convey between 25,000 and 30,000 horse-power to the various municipalities between these two points. It is proposed to build an electric railway along the right of way. Hon. Adam Beck explained that three or four routes had been suggested, and that the most advantageous one would be selected.

Ottawa, Ont.—In view of the new loan and subsidy, which the Canadian Northern interests are now busy negotiating, and which the government is proposing to grant, the question was asked by A. K. Maclean, of Halifax, as to what amounts have been paid since August 28, 1912, by the minister of finance and the receiver-general to the Canadian Northern Company from the proceeds of the authorized loans. In answer to the question it was stated that from the date mentioned until March 20, the Canadian Northern had received from the Dominion treasury $6,901,991.25 from the proceeds of loans authorized in connection with their line from Montreal to Port Arthur. The maximum amount payable is $35,000 per mile for 1,050 miles.

Winnipeg, Man.—The Canadian Domestic Engineering Company, Limited, announces the opening of a branch at Winnipeg, in the Alfred Building. The western manager is Frank W. Walker, M.E., of Winnipeg. Mr. Walker is a McGill graduate, and was formerly with Babcock & Wilcox Company, and more recently with the Transcona Shops.

PERSONAL.

DR. HARRIS LOGAN has been appointed medical health officer of Niagara Falls, Ont.

MR. ANGUS SMITH has resigned his position as city engineer of North Vancouver. His resignation will take effect at the end of April.

MR. HENRY JUNGERMAN, formerly with the Motive Power and Inspection Department of the Harriman Lines, has been appointed railway representative of the Tate-Jones & Company, Inc., of Pittsburg, Pa.

J. C. DUFRESNE, M.Can.Soc.C.E., M.Can.Mi.Inst., formerly of Penticton, B.C., is now associated with the consulting firm of Cummins & Agnew, Vernon, B.C. Cummins & Agnew make a specialty of municipal and irrigation work.

ARTHUR H. BLANCHARD, M.Can.Soc.C.E., professor of Highway Engineering in Columbia University, on March 31st delivered an illustrated lecture on "Highway Engineering in Europe and America," before the Brooklyn Institute of Arts and Sciences.

MR. JOHN A. BENSEL, M.Am.Soc.C.E., New York State Engineer, Albany, N.Y., on March 20th delivered an illustrated lecture on "Inter-relationship of Highways, Waterways and Railways" before the graduate students in Highway Engineering at Columbia University

JAMES COWIN, manager at Winnipeg for the C. A. P. Turner mushroom system of construction, has left Canada to take charge of Mr. Turner's affairs in Texas. A. W. Fosness and S. J. Sieverson, both of Mr. Turner's head office at Minneapolis, have taken charge of the Winnipeg office.

MR. H. R. PARSONS, C.E., graduate of the University of Michigan, has been appointed city engineer of Peterborough, Ont. Mr. Parsons was for six years employed as assistant city engineer of Ottawa, being in charge of the construction of pavements, sewers and waterworks systems in that city.

W. J. WELLER, provincial bridge builder for Manitoba, has been appointed superintendent of construction of bridges on the main line of the C.N.R. at the coast, and has left to commence operations. Mr. Weller has been with the G.T.P. for some time and for many years was connected with Mackenzie and Mann interests.

W. H. BREITHAUPT, C.E., is continuing the engineering office in which he was formerly associated with the late E. H. Keating. Chas. B. Kingsley, C.E., will be associated with Mr. Breithaupt. Mr. Breithaupt is a member of the Canadian Society of Civil Engineers, American Society of Civil Engineers and also of the Institute of Civil Engineers of Great Britain.

VIRGIL BOGUE arrived in Victoria, B.C., recently for a consultation with the minister of railways, Hon. Thos. Taylor, respecting work for which he is the consulting engineer in British Columbia. Mr. Bogue, whose headquarters are in San Francisco, recently reported upon the projected dock improvements for the Grand Trunk Pacific Railway Company at Prince Rupert. Recently the Canadian Pacific Railway Company engaged Mr. Bogue to report upon the projected Rogers' Pass tunnel, for the construction of which tenders are now being called.

OBITUARY.

ALBERT G. MACFARLANE, district engineer of the National Transcontinental Railway, dropped dead in his room at the Russell House on April 4. He was a native of Almonte, Ont., and had been at various periods in the employ of the Parry Sound, Midland, Algoma, and Canadian Northern Railways. He was 52 years old.

GEORGE P. BROPHY, C.E., superintending engineer of the Ottawa River works for 36 years, one of the founders of the Ottawa Electric Street Railway and Lighting Companies, and a figure in the local financial world, died at Ottawa on April 4th. He was 65 years of age. As superintending engineer Mr. Brophy was actively identified with important government projects all over the Dominion. Besides being a director of the Ottawa Electric Company and the Ottawa Electric Railway Company, the deceased held extensive interests in British Columbia and other provinces,

as well as locally. He assisted in forming the Ontario Graphite Company, the Dominion Carbide Company, Ahearn Electric Heating and Manufacturing Company, Locomotive and Machine Company of Montreal, the Thousand Islands Land Company, the Ontario Smelting, Milling and Refining Company, and other similar organizations. He was a director of the Ottawa Gas Company and a vice-president of the Ottawa Trust and Deposit Company.

SOCIETY MEETINGS.

A joint meeting of the Electrical and Mechanical Sections of the Canadian Society of Civil Engineers was held on Thursday, April 3rd, at 8.15 p.m. A paper on "Electrification of a Reversing Mill at the Algoma Steel Company," by B. T. McCormick, A.M.Can.Soc.C.E., was read by the author.

Dr. John W. S. McCullogh, chief health officer of Ontario, will deliver an address on Friday, April 11th, 1913, at 8 p.m. on "The Evolution of Public Health," at the Engineers' Club, Toronto. The library committee announces that a series of interesting lectures have been arranged for.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose: Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan. Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, April 17, 1913 Contents of this issue on page 595

The Canadian Engineer

An Engineering Weekly

THE GEORGIAN BAY—OTTAWA—MONTREAL WATERWAY

By J. A. MACDONALD

The Georgian Bay-Montreal Canal project is one of the most important the Federal Government of Canada has to face. At the time the surveys for it were being carried on it was a subject of considerable discussion, but of late on account of its political aspect parliamentarians and politicians have been more interested in it than engineers. Each year, the expansion of trade and increased railway traffic between east and west makes the canal more important. Mr. Macdonald, of the Topographical Surveys Department, Ottawa, briefly reviews the proposed course of canal and the difficulties encountered, gives figures and data, and discusses the question in a way which we believe will prove interesting even to those who, previously acquainted with the subject, have perhaps of late years grown hazy, and who will no doubt be glad to refresh their memory and consider things from the viewpoint of the author.—[Editor.]

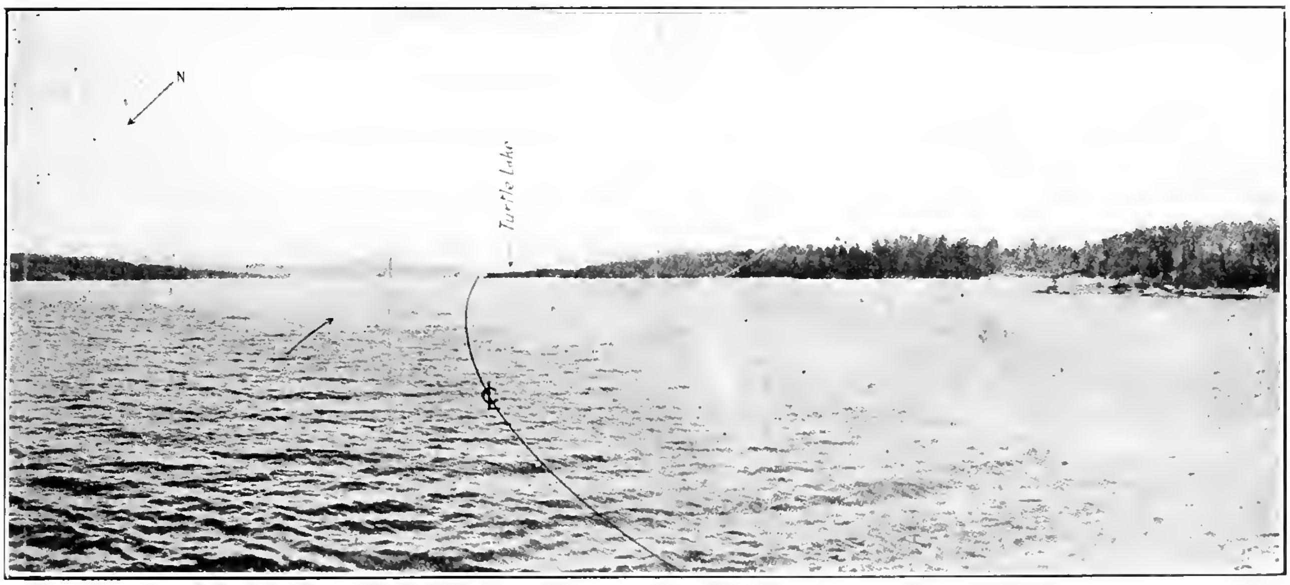


Fig. 1.—Summit at West End of Trout Lake.

It is the opinion of prominent Canadian shipping interests that Canada has little to fear from the improving of the Erie Canal route, or, indeed, any transportation route that the United States can construct, if she takes but full advantage of the great Montreal resources which Nature and Providence has given her.

Canada has the control of the bulk of the export and import trade of the great North-West of the continent if she should want it, as a glance at the accompanying map will show.

Trade will always take the shortest and cheapest route. This being the case, it is clear that if Canada has such a route its proper use will ensure her the trade, and this we find in the proposed Georgian Bay-Ottawa-Montreal waterway, usually known as the Georgian Bay Canal.

The survey, which was completed two years ago, required nearly three years' hard work by a competent staff of engineers. It has been completed in such a detail as not only to determine the most economical and feasible route, but to afford ample data for a close estimate of cost.

Commencing at Georgian Bay, the line proceeds up the French River by one of its five estuaries, known as the French River Channel, to the village of that name, where the first lock is encountered. By this lock the line is taken into the Pickrel River, which is followed for 37 miles to the second lock, then a lift of 24 feet brings the canal again into the French River. This stream is utilized for a distance of 14 miles to the third lock. Another lift of 24 feet at this

point and then comes a stretch of practically free navigation in Lake Nipissing extending 32 miles, at the end of which is a lock that elevates the east-bound craft from Lake Nipissing into Trout Lake. Here the summit is reached, 677 feet above sea level, and 24½ miles long, mainly free navigation, but requiring small cuttings at places where the channel is contracted. The channel leads directly into Lake Tallon (an expansion of the Mattawa River) which is to be raised 37 feet by a dam constructed at the head of Tallon Falls. The summit level, therefore, extends from Trout Lake to Tallon Falls. The run-off from the drainage area supplying this level, however, was not deemed, by the engineers, to be sufficient to work the canal system to its full capacity, and a painstaking search for additional supply was instituted. The river Amable du Fond, flowing northward, empties into the Mattawa lower down, and it was found that transportation of supplies, etc., so that the cost will be reduced to the minimum for this class of work.

From Mattawa to the city of Ottawa, below the Chaudiere Falls, there are 12 locks, with a total fall of 360 feet, and at three points locks are grouped in flights. One of these flights is to be at Ottawa to overcome the falls, a drop of 55 feet between the levels above and below the Chaudiere Falls. The other flights are to be at Chats Falls and the Rocher Capitaine Rapids. The single locks will be at Cheneaux Rapids, the Rocher Fender, the Paquet Rapids and Des Joachims.

From Ottawa to Montreal the main channel of the Ottawa River is followed, five single locks utilized to bring the proposed waterway to the level of the St. Lawrence. These locks would be at Hawkesbury, Point Fortune, Ste Anne and Verdun, and finally one opposite the custom house in Montreal.

Fig. 2.—Map Showing Advantageous Location of Georgian Bay Canal.

by means of a flume and tunnel it could be diverted so as to empty into the summit level, thus giving a large surplus of water.

Leaving the summit level the line passes to the north of the main channel of the Mattawa River, across quite a high divide and thence into the level below, through two flights of locks of 60 feet each, a drop of 120 feet. Following down the Mattawa, the Ottawa River is reached at the town of Mattawa. After a passage through three locks, one at Les Epines Rapids, one at Champlain Chute, above Mattawa, and one lock located at the town of Mattawa itself, a fall of 57 feet in the three, is a total drop of 177 feet from the summit.

This section involves the heaviest work of the whole line, but the close proximity of the line of the Canadian Pacific Railway eliminates the features of excessive cost of

On account of expected opposition to the adoption of the latter section of the route, because of the frequent crossings which it will involve of the trunk lines of railway centering in Montreal, another route which would obviate this difficulty has been investigated. It proceeds by the River Des Proiries lock of Montreal, and will debouch upon the St. Lawrence at Bout de Lisle, the descent being accomplished by three locks.

In all, the canal from Georgian Bay to Montreal will be 400 miles long. From Montreal to the summit the distance is 334 miles, with a difference of 659 feet in elevation; and from the summit westward it drops 99 feet in 83 miles. The locks are to be of sufficient capacity to pass the largest freight boats on the lakes, vessels which are gradually approaching 625 feet in length, and are even now 60 feet beam,

with a carrying capacity of 12,500 tons on a draught of 20 feet.

Such vessels are capable of carrying over 450,000 bushels of grain. It is well known that from the head of lake navigation to Liverpool the saving in distance is nearly a thousand miles by the Georgian Bay Canal route, as compared with the Chicago-New York route, which also involves the disadvantage of a long carriage by the Erie, a mere barge canal. As compared with the St. Lawrence Canal route, the Ottawa and Georgian Bay Canal would effect a saving in distance of nearly 400 miles in the transportation of grain from the lakes to the head of the Atlantic navigation. This would mean a saving, on an average, of nearly 34 cents per ton, and about 1 cent per bushel in wheat, in favor of the Ottawa route.

Last year between sixty and seventy million bushels of wheat alone were transported by vessels via the existing longer routes. The magnitude of the traffic in which the new canal would participate under advantageous conditions may be further estimated from the fact that the value of freight passing through the Soo canals amounts to more than $600,000,000, upon which the freight earnings amounts to $40,000,000.

The size of the Georgian Bay waterway and of the locks was determined from considerations turning on the present traffic on the Great Lakes. There would obviously be no advantage in designing the canal to deal with a larger class of boat than is able to pass the Sault Ste. Marie Canal, joining Lake Superior with Lake Huron. The depth over the sills and the channels leading to the Sault Ste. Marie locks, as well as the depth of water in the terminal harbors, at present limit the loading draught to 20 feet, so that it was felt that a depth of 22 feet, as fixed for the Georgian Bay Canal, would meet present requirements and allow a slight increase of draught for the future.

Starting from Port Arthur, the distance to Montreal via the proposed canal is 934 miles, via Lake Erie and Welland Canal, 1,216 miles; via Buffalo and Erie Canal to New York, 1,358 miles, giving a difference in favor of the projected canal of 282 miles, as compared with the present St. Lawrence route, and of 424 miles as compared with Buffalo and New York route.

Fort William to Liverpool, via Georgian Bay Canal ....4,123 miles
Fort William to Liverpool, via New York........4,929 miles

Giving a difference of 806 miles in favor of the Georgian Bay Ship Canal.

Taking into consideration the delays caused by passing through the restricted channels where the speed of vessels has to be reduced, and allowing forty-five minutes for each lockage, it is computed that the time of transit from Georgian Bay to Montreal will be about seventy hours, or one and one-half days faster than any existing water route from the head of the Great Lakes to an ocean port. The canal cutting for the entire route is twenty-eight miles. The length of submerged channels to be excavated is sixty-six miles, and there is, apart from the above, an aggregate of 14½ miles where obstructions, such as shoals, sharp bends, etc., have only to be removed to give very wide channels. Therefore, of the 440 miles of this waterway 108 miles requires excavation, leaving 332 miles of natural channel in lakes and rivers which will only require the raising of the water in the way of improvement. The length of the season of navigation is estimated 210 days.

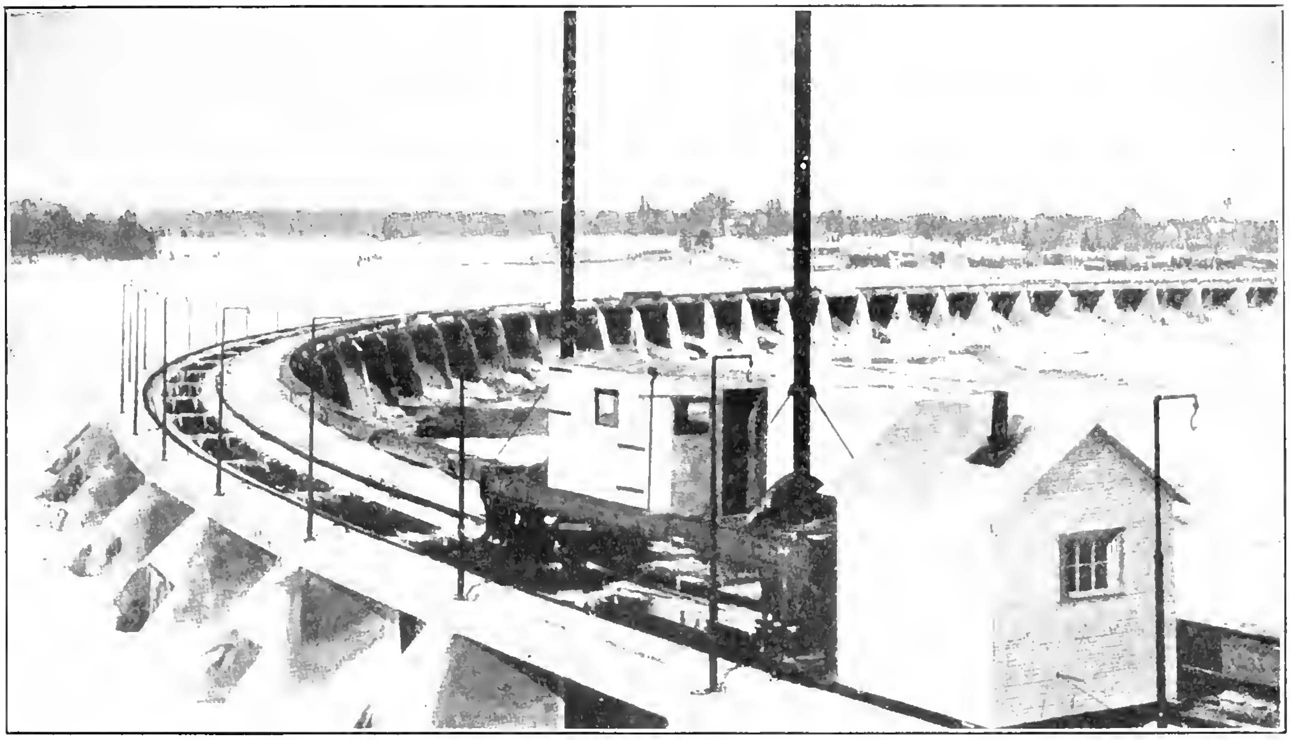


Fig. 3.—Chaudiere Regulating Dam, Ottawa River.

It will be necessary to build forty-five dams for navigation purposes alone in connection with the undertaking. Many dams will be required for storage purposes.

The development of electrical power is another important consideration in connection with the construction of the Georgian Bay Canal. A conservative estimate places the water-power development which will be rendered available by navigation dams at 1,000,000 horse-power.

One of the most important features of the projected undertaking, affecting the city of Ottawa particularly, is the regulation of the water supply of the Ottawa River. The range of flow of the Ottawa, at the city of Ottawa, is from a maximum of 194,000 cubic feet per second to a minimum of

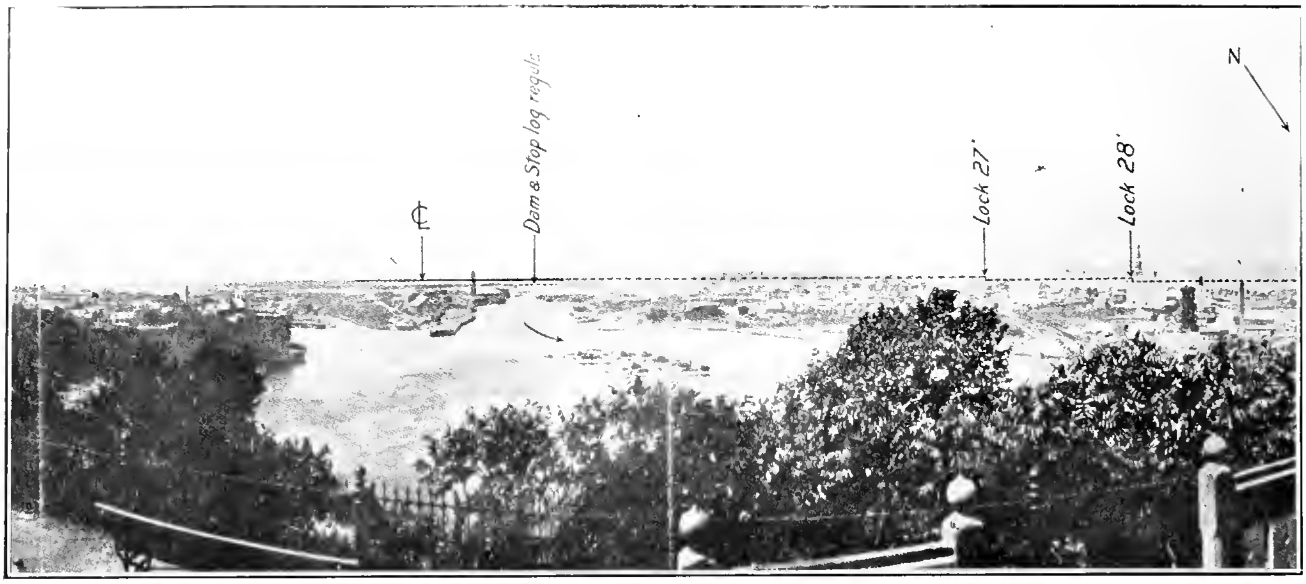


Fig. 4.—Hull, Quebec, Showing Canal North of City.

12,000. By the system of dams and reservoirs required for the operation of the canal, a mean flow would be maintained the year round.

Estimates of the approximate cost of the canal which have been given out of late will be found to be based upon mere guess-work, and superficial knowledge of the ascertained conditions. None of these, it may be taken for

Fig. 5.—Eastern Entrance to Canal, Montreal Harbor.

granted, has been authorized by the department of public works, under whose auspices the survey has been conducted.

These estimates have placed the cost at about $105,000,000. This, it is believed, is over five per cent. in excess of the actual estimate based upon the completed survey.

Montreal is, according to the latest statistics, entitled to rank second city in shipping of all the cities on this continent, and the Federal Government has, during the past fifteen years, expended large sums in improving the ship canal, so to speak, between Montreal and Quebec. To complete a channel from Montreal to the sea, 30 feet deep at lowest tide, it is estimated that 75,000,000 cubic yards will have to be removed, a great portion of which has already been done.

The opening of this Georgian Bay Canal would open a trade between the West and the Maritime Provinces and Newfoundland, which is much to be desired; the west and the east having . . . that they ought to interchange if given such cheap transportation as the Georgian Bay Canal would give. It would make the Ottawa River and its tributaries a great channel of watercourse between Montreal and the country lying at the head waters of the Ottawa River in the provinces of Quebec and Ontario and between them and Hudson Bay.

The opening of the canal to the head of Lake Superior would prove to be an incentive of a great further series of canals and waterways through the Lake of the Woods, Lake Winnipeg and Saskatchewan River to Edmonton, so giving Canada a waterborne system right to the very heart of the continent, which would create new business and new activities along the whole route by the enormous electrical power that would be developed by the construction of the canals—power that would in a short time result in the building up of manufactures where success might almost be guaranteed, seeing that they would possess almost the cheapest motive power and transportation that it is possible to make.

THE RED AND BLACK ROADS OF SASKATCHEWAN.

During the fall of 1912, Prof. W. W. Andrews, M.A., LL.D., at the instance of the Provincial Board of Highway Commissioners, conducted laboratory and other investigations into the qualities and possibilities of Saskatchewan clays as materials for road making. The following is a condensed report of Dr. Andrew's work and findings prepared by himself. Having been carried out only on an experimental scale during last summer, it is not possible as yet, of course, to determine just what the practical value of the results described will be. That can be fully determined only when the roads have been subjected to several years of wear and cost of upkeep estimated.

Very little experimental investigation was necessary to establish the fact that at a comparative low temperature the clays of the prairie almost without exception will burn to a porous, gritty material, the properties of which are a direct opposite of the corresponding ones in the clays. The clays are nearly impervious to water, especially when well puddled, the clay clinker is readily porous; the clays are weakest when wet, the clinker is stronger; the clays do not wear to a dust, the clinker will; the clays expand when moistened, the clinker powder shrinks; the clays are adhesive, the burnt clay is not, and the clinker varies in color from reddish yellow through a brown to a bright rouge, great contrast to the slaty colors of clays.

It became evident that if this clay clinker can be produced at a cost sufficiently low, we would have a material which we could use to mix with the clay to counteract its troublesome qualities and which would prove of immense service in making roads in those parts of the province remote from sand and gravel beds. In some parts of the province natural mixtures have been made of sand and clay, and good roads in all seasons of the year are the result—witness many sections in the neighborhood of Estevan and Weyburn in the Duck Lake region. The mixture which has been chosen in this experimental work is one part of raw clay to four parts of clinkers, with the expectation that from untreated portions of the road clay will be carried on by the wheels of vehicles and dropped upon the clinkered section. There is danger that at first muddy wheels will tear up sections of clinker until the road has become properly mixed and compacted through traffic. In such a mixture the clay will keep it dustless and strong during dry weather, and during wet weather the sharp nature of the clinker will hold the wheels up, while at the same time the porosity will permit the excess of moisture to drain out of the road surface very readily. In these respects the clinker will be superior to sand and gravel because it will absorb a larger percentage of moisture before it appears to be wet. Experiments with clay taken from Albert Street, Regina, show that clay containing 30 per cent. of moisture will pack to a tough resistant mass, and observation of traffic showed that at this percentage the clay packed solidly under the wheels.

Experiment also showed that by using good coal the clinker could be produced at an economical rate, and that straw would give sufficient heat for this purpose. It remained to be demonstrated that the straw (the fuel universally abundant throughout the settled portions of the province) can be used for producing clinker at a rate sufficiently cheap. The great handicap to this form of fuel is found in the fact that a fireman needs to be in constant attendance upon a kiln during the burning. How this works out will appear in the analysis of costs at the conclusion of this article.

This much having been done, Mr. A. J. McPherson, chairman of the Board of Highway Commissioners, decided to lay out a piece of experimental road. North Winnipeg Street, Regina, was chosen, where already an experimental stretch of clay and gravel road was being laid down. Mr. J. E. Milne took charge as engineer of the work.

As the designer of the road Prof. W. W. Andrews named it the Red Road of Saskatchewan. First a trench was dug along the centre of the road to an average depth of two or two and one-half feet and a three inch tile laid down, covered to a depth of one inch. The trench was divided in sections six feet long and each section was used as a furnace. This plan had the great advantage that it burnt the sides of the trench, thus producing two porous sheets of burnt clay, extending from the surface down to the tile. It also clinkered the clay covering of the trench and a portion of the road to each side of the trench. Much time and expense was given to this side burning, but while with a steady fuel, left for a few days to burn itself out, the side burning was all that could be desired, we were defeated in our attempts to accomplish this in any adequate way with the straw fuel.

The central underdrain adds very considerably to the first expense of construction, and it has this defect that it weakens the road bed for a year until the filling has settled down. On account of the permanent nature of a well laid underdrain but one-tenth of its cost should be charged against the first cost of the road, and once laid down in proper manner it will last as long as the road is used. Moreover, if it be opened to the side ditches by drains to alternate sides of the road, every two hundred feet or so, the prairie winds all summer long will suck the air through the heart of the road bed and reduce its moisture to at least 13 per cent. This is the percentage of moisture found in clay from a wheel track on Albert Street, Regina, dug from under the snow. At this percentage the clay possesses great compressive strength; if packed it will be almost as hard as marble, when frozen it will shrink but little, and when thawed out will not soften. A road bed dried out and kept dry will in time of rain be capable of absorbing hundreds of tons of water per mile, before it reaches the dangerous limit of 30 per cent. The porous clinker in the surface metalling of the road will permit the water to spread rapidly from the surface into the bone dry bed ready to receive it, and then to the central drain. When a road has been constructed in this way each wheel track becomes a watershed, from which in two directions any excess of water may flow rapidly, to the outside ditches on the one hand and to the central underdrain on the other.

Until a method be found for cheaply calcining the sides of the trench it will be better to dig the trench as narrow as possible and fill it with burnt clinker. One of the firms manufacturing mechanical ditchers is preparing estimates of a machine costing in the neighborhood of $1,500, which will cut a six or eight inch trench to the required depth,

and mechanically deposit the tile in the bottom. This will reduce the cost of digging and it will require but little clinker when mixed with one-half its amount of raw clay to fill the trench. The after settling will be greatly reduced when the trench is so filled.

After the drain is completed the grading is done in the usual way and the surface rolled. If left to be puddled and packed by traffic the clay, even to the sods from the road side, which is the most difficult material to treat, is compacted sufficiently to be broken up by the plough into hard lumps ready for the kilns.

Preparing the Clay Clinker.—The method of the burning the clay is as follows: Iron crates were made to provide a fire box and over these the lumps of clay made by breaking up the roads which had been graded and rolled are piled. In practice it will probably be well to grade the road and leave it for a month or so for the traffic to pack and then begin the burning. Prairie sods will form good clinker only when it has been puddled and packed, as a rain and subsequent traffic will do it. The addition of salty water to the sods improves the clinker.

Eight hours firing produces a fine mass of clinkers, from two to two and a half cubic yards being produced in each kiln. A little straw is spread over the road bed and then the clinker is spread mixed with a little straw and the proper amount of raw clay. The straw serves several purposes. It prevents the clay of the under bed working up and ingulfing the clinker on the surface, and its juice has a remarkable power to lessen the shrinkage of the clay and to increase its tensile strength. It supplements the binding power of the clay which is mixed with clinker, and by its cushioning tendency it reduces the crushing effect of the traffic on the clinker. In fact it acts as the swaddling bands of the young road.

The last operation is the rolling of the road, and that thoroughly done, the road is ready for use.

Such a road should be comparatively dry fifteen minutes after a rain. It should never load the wheels, nor ever grow dusty, and if the split log drag or the lap drag be faithfully used it should prove a cheap and eminently satisfactory road. Just what it would require in the way of maintenance it is at present impossible to say. Probably if the drag be used as it should be, the addition of a couple of inches of fresh clinker to the central portion of the road once in five years will be all that is required to keep it in the finest condition.

It may be of interest to point out that the clinker will serve many other purposes. For private roads and paths in parks and door yards it will prove a beautiful and efficient material which will prevent the tracking of mud into the house. It will also be useful around schools and country churches, where the bright red color will show in pleasing contrast to the green of the grass. Ground fine it is a perfect substitute for sand in mortar, making a lighter and stronger plaster than sand lime mortar. It can be so treated that it will form a good filler for cement concrete and asphalt pavement. The homesteader can build a considerable portion of his house from the clay dug from his cellar, importing the lime only.

The Cost of a Red Road.—The cost of the first portion of the experimental road was $1.80 per lineal foot, the latter portion cost $0.82, and after checking over the figures with Mr. J. E. Milne, the cost is estimated as follows:

Two men at $2.50 per day tending five kilns producing and spreading 10 cubic yards of clinker per day	$5.00
Hauling straw	3.00
Oversight	1.00
Wear and tear of crates	.80
Cost of ten cubic yards of clinkers	9.80
Cost of one	.98
Therefore cost of metal per lineal foot	.33
Grading cost	.16
Total	.49
Which is equal to	$2,500 per mile
The underdrain costs	1,440 per mile

The total cost of clay clinker road underdrained and covered with eight inches deep of clinker and 12 feet wide will be $3,940 per mile. A gravel road with equal depth of metal costs $4,150 per mile, estimating material at $1.80 per cubic foot laid on road.

A mechanical ditcher will reduce the cost of underdrain to two-thirds the above cost, namely, $1,000 per mile. The drain once in will provide drainage and ventilation of the road bed. It may be found that the underdrain may with safety be omitted altogether. If so this will reduce the cost to $2,500 per mile.

If compact fuel such as coal be used, so that once charged and lighted a kiln may be left to burn itself out, two men could build, charge and open 15 kilns per day, and estimating the fuel at $9.00 per ton, a cubic yard will cost $0.47, and a lineal foot will cost $0.16, instead of $0.33 as above, while the cost of a graded road per mile will be $1,643 instead of $2,500. We may confidently expect that in every part of the province red roads without underdrainage can be constructed for about $2,000 per mile, and if we can cheapen fuel, as a future article will show to be possible, these figures will be somewhat further reduced, or at least made more certainly realizable.

The Black Road of Saskatchewan.—Briefly described this patent road is constructed as follows: The underdrain is put down and made to open every two hundred feet to alternate sides of the road. This secures sufficient drainage and effective ventilation, which ever way the wind blows. The road bed is graded, covered with three inches of straw and then sprinkled and puddled by traffic or by the use of a packer, or best of all by the feet of a few cattle driven back and forth along the road till the straw is tramped well into the mud. Then as it dries it is rolled until it gains that glistening surface and marble-like hardness so marked a feature of the prairie roads. The surface is then swabbed with a tarry asphalt and then three inches of asphalt is laid filled with powdered clinker and little slabs of clinkers, which when spread and rolled lie over each other in successive layers. This produces a schistose or layered structure, which will prove very strong per inch of thickness. The road may be made still stronger if chicken coop wire (one or two inch mesh) be laid on the tarry layer and the asphalt poured over it so that it becomes thoroughly imbedded in the asphalt sheet.

The little slabs are made by spreading clay on the surface of the pavement already constructed and passing the steam roller over it. They are then cut with a sharp spade or knife rake to the desired sizes, dried a little and burnt in a rotary calciner or crate. Being somewhat porous when mixed with hot asphalt, they suck in a small portion of the bitumen on cooling, and by this means become much stronger than stone of the same original hardness. The adhesion between the bitumen and the filler is perfect, being not merely a surface contact, but a surface impregnation.

It is hoped for streets in small towns and villages, the suburbs and annexes of large cities, for sidewalks, and in many cases for country roads this type of road will prove a strong, smooth, mudless and dustless road, easy to keep up and sufficiently cheap to be considered a practical proposition.

The cost cannot be accurately estimated till an experimental piece has been constructed. The burnt clay filler will cost no more than one dollar a cubic yard, where crushed stone costs $4.20 per cubic yard, and the filler constitutes five-sixths of the volume of asphalt pavement. To this great reduction in cost may be added that achieved by the omission of the base of cement concrete. On the other hand the preparation of the gumbo road bed will cost more than the graded surface on which the concrete sheet is laid, and to this must be added the cost of the underdrain which cannot be left out in the construction of a black road.

The future of the black road depends upon the answer which future experimental work may find for the question: "Will properly prepared gumbo form a reliable road base for heavy traffic if protected from moisture?" This we all know, that the naked gumbo in dry weather bears up in dry weather under the heaviest traffic. We should not expect it to prove weaker when waterproofed and protected by a sheet of heavily rolled asphalt.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz, M.E.

(Continued from page 556 of last issue.)

Damage and Danger Produced by Stray Electric Currents on Underground Piping.—It has already been pointed out that damage from electrolysis to underground piping usually results in the neighborhood of the power station from current leaving the pipe to flow to the rails and to other return conductors, and that service pipes in the same locality are most frequently damaged where they cross under and are positive to trolley rails. The destruction of underground piping by electrolysis is, however, by no means confined to the so-called positive districts in the neighborhood of the railway power station, but will occur at any point in the pipe where current leaves the pipe to flow to the surrounding soil In Fig. 10 is shown a water pipe and trolley line near a salt water bay, about 8 miles distant from the railway power station supplying this trolley road. The trolley rails at this point are about 25 volts positive to the water pipe; that is, the water pipe is in a highly negative district. The railway power station is located on the shore of a salt water bay, and its negative bus-bar is grounded through low resistance ground connections, so that large currents leak from the trolley rails at points shown in Fig. 10, and flow through the ground and the salt water of the bay to return to the negative bus-bar at the railway power station. These stray currents in their path encounter the water pipe and flow part of the way thereon. The values of current indicated on the pipe are average values obtained from 24-hour records. It is seen that in one section large currents leave this water pipe to flow to the surrounding soil and from there to the salt water. An examination of the pipe at this point also indicated that it had been badly corroded by electrolysis This, therefore, affords an excellent example of destruction by electrolysis of a water pipe in a highly negative district.

In Fig. 11 is also shown a water main and service pipe crossing under trolley rails and under telephone ducts. At this point the pipe is also negative to the trolley rails, but positive to the lead sheaths of the telephone cable, the potential condition with reference to the cables being caused by the fact that the telephone cable sheaths are bonded to the railway return conductor at the power station, As shown in the diagram, current flows from the rails to the water pipe, and leaves the water service pipe where it crosses under the telephone ducts to flow to the cable sheaths, resulting in the destruction of the service pipe. An examination showed pits extending entirely through the service pipe, directly under the telephone ducts and facing the ducts. This, therefore, affords another illustration of destruction of a service pipe in a negative district.

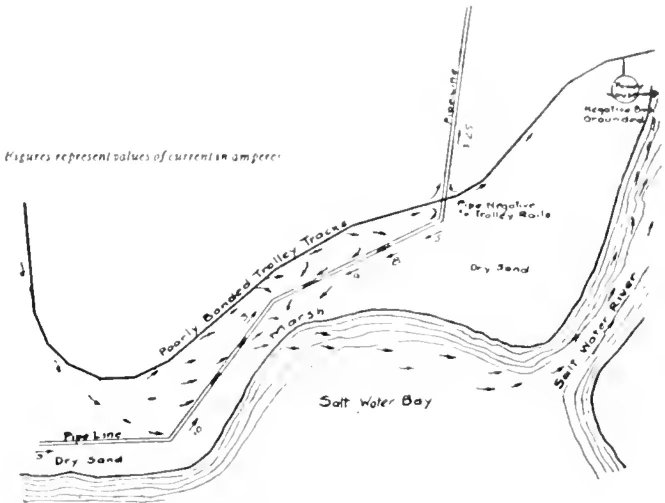


Fig. 10.—Diagram Showing Stray Current Leaving Water Main in Negative District.

Besides danger from electrolytic destruction of the pipes, stray currents, where they flow on underground piping systems, frequently enter buildings through service connections and produce a serious fire hazard. For example, current may flow into a building through a water service pipe, then flow from the house water piping to the house gas piping, and then out from the building through the gas service pipe. An example of this kind frequently met in practice is illustrated in Fig. 12. Such contacts between service pipes, or between a service pipe and the lead sheathing of a telephone or a power cable, frequently occur through metal ceilings,

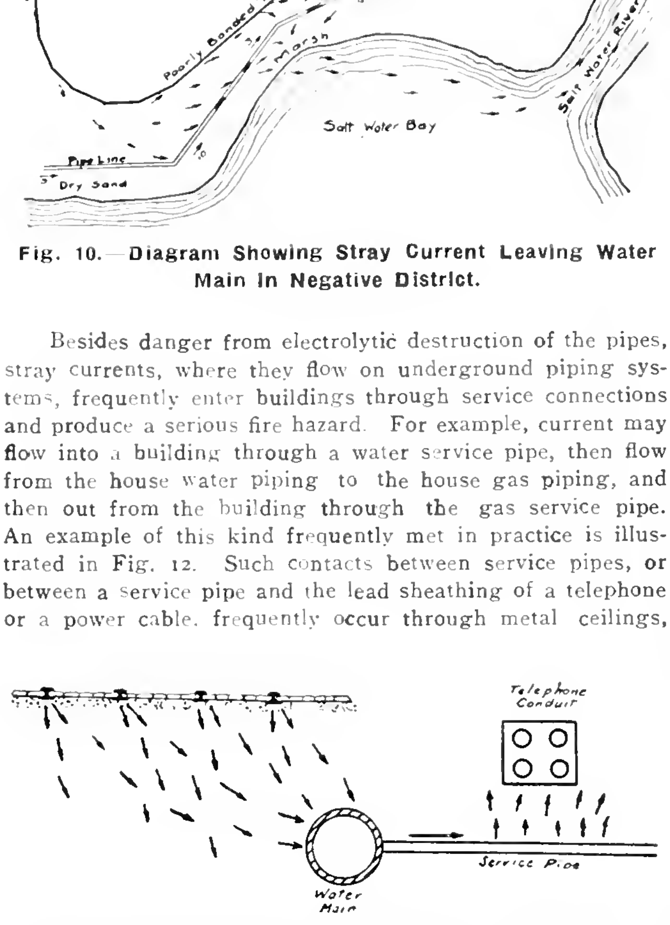


Fig. 11.—Example of Service Pipe Negative to Trolley Rails and Destroyed by Electrolysis Due to Currents Flowing from Rails to Pipe and from Pipe to Telephone Cable Sheaths.

or where the pipes rest against each other. Since dangerous heating may be produced where the current flows through such contacts, or where vibration may momentarily separate the contacts and produce an arc, nearby inflammable material is in danger of being set on fire. The author has in fact found many cases where currents up to 30 amperes were flowing into-and-out of buildings through service pipes or lead cable sheaths. Evidences or arcing having occurred between such contacts in buildings have also been found. There is no doubt that many fires have started in this way, but it is always difficult to prove the cause of a fire because of the destruction resulting from the fires.

Corrosion Not Caused by Electrolysis.—While electrolysis is undoubtedly responsible for much destruction of underground piping and other underground metallic structures, the author has frequently been asked to examine cases where the destruction had clearly not been produced by electrolysis from stray currents, but by altogether different causes. It must be remembered that corrosion of a metal from electrolysis can only occur where current leaves the metal to pass to an electrolyte, such as damp soil. Service pipes have sometimes been found destroyed inside of cellar walls where they were not in cantact with an electrolyte; the corrosion here is purely of a chemical nature, and not in any way chargeable to stray current electrolysis. Brass or copper pipes and fittings and brass condenser tubes in contact with salt water also corrode quite generally, but this is

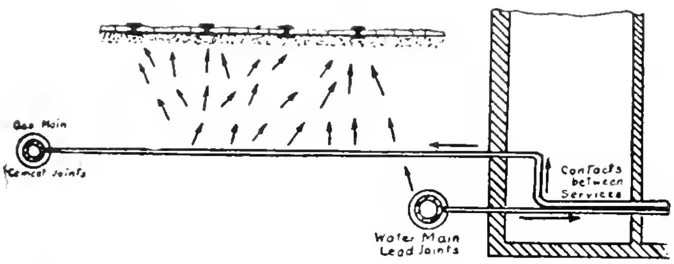


Fig. 12.—Showing Stray Currents Entering and Leaving Building Through Service Pipes and Causing Fire Hazard and also Destroying Gas Service Pipe by Electrolysis.

caused by electrochemical action of the salt or contaminated water upon the metal, and not by electrolysis from stray currents.

Remedial Measures.—The only one complete remedy for electrolysis is the use of a completely insulated return circuit. Such railways may be provided with double overhead trolley wires, as used (for example) in Cincinnati and Havana, Cuba; or with an insulated outgoing and return conductor in underground conduits, as used (for example) on the surface lines on Manhattan Island and in Washington, D.C.; or with separate insulated third and fourth rails for the outgoing and return current, as is used on the Metropolitan District Railway in London. With these systems the running tracks are not used as a part of the electric circuit, and as both positive and negative sides of the circuit are insulated no stray currents are produced.

Where a road operates on private right-of-way the rails can often be practically insulated from ground and the escape of current from the tracks prevented. For surface roads this can be practically accomplished by placing the rails on wooden ties above ground, using broken stone for ballast and keeping the rails out of contact with ground. In the case of railway lines operating on elevated structures the rails can be fastened to wooden ties and kept out of contact with the structure. These rails, supplemented where necessary with negative feeder cables, also insulated from the structure, can then be used for the return conductor. In this way the return circuit is quite thoroughly insulated from the elevated structure and from ground, and stray currents are entirely prevented.

A number of remedial measures intended to reduce stray currents from electric railways using the grounded rails for a return conductor have been tried. These methods may be divided into two classes, the first class aiming to remove the current harmlessly from pipes by metallic connections or bonds between the pipes and the railway return circuit, the second aiming to minimize stray currents through ground.

Since stray currents cause damage only where they leave pipes to flow to the surrounding soil, attempts are frequently made to prevent destruction from electrolysis by connecting or bonding the pipes or other structures by means of metallic conductors to the rails or to the negative return circuit, so as to remove the electric current by metallic conduction and thus prevent corrosion from electrolysis. As the lead sheaths of underground cables form continuous and uniform metallic conductors, it is, therefore, possible to protect such cable sheaths against electrolysis by bonding or connecting them to the railway return circuit. This practice is, however, exceedingly objectionable because by such bonding the trolley rails are paralleled by a low resistance grounded conductor which greatly increases the tendency for current to flow through ground from the tracks. The second objection is that such bonding makes the cable sheaths negative to all other underground structures, such as water and gas pipes, thereby setting up a tendency for current to flow from such pipes to the cable sheaths. This effect is illustrated in Fig. 13. In this a case is shown, frequently found in practice, where the pipe is everywhere negative to the trolley rails, except in a very restricted area in the immediate vicinity of rail feeder connections, but is everywhere positive to the underground cable sheaths. The pipe is consequently everywhere in danger from stray current flowing from the pipe to these cable sheaths. In one city, in fact, where there was an underground cable system with its lead sheathing bonded to the railway return circuit, it was found that the underground pipes were everywhere negative in potential to the trolley rails, and were, therefore, considered immune from electrolysis. An investigation showed, however, that these pipes were at all points highly positive to the underground cable sheaths and were in fact in considerable danger from electrolysis. It has been frequently found that, where gas or water service pipes cross bonded cable sheaths, currents are caused to flow from the service pipes to the cable sheaths, and produce gradual destruction of the service pipes. A case of this kind was illustrated in Fig. 11. In the case of one city 19 service pipes were destroyed in the course of one year directly where these pipes cross telephone ducts containing cables whose sheaths were honded to the railway re-

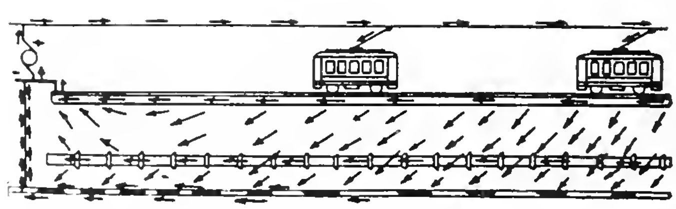


Fig. 13.—Showing Path of Stray Railway Currents and Showing Effect of Bonding Underground Lead Cable Sheaths to Negative Bus-Bar of Power Station.

turn circuit. This method of bonding, therefore, protects continuous conductors like lead cable sheaths, but at the expense of other underground metallic structures which cannot be so treated. Its effectiveness as a protective means depends absolutely on uniformity of conductivity of the conductor to be protected, but it is not generally applicable to underground piping systems, because the latter do not form continuous electrical conductors, but are more or less discontinuous networks. While lead calked joints usually have a relatively low resistance, it frequently happens that they develop such high resistances as to make them practically insulating joints, due undoubtedly to the formation of oxide coatings. Cement joints and cement pipes have such

a high resistance compared with iron pipes that they are practically insulating.

Bonding of pipes to the rails or to the negative return circuit can only afford local protection to the extent that the piping connected forms a continuous metallic conductor, and this latter is an unknown and indeterminate quantity in a piping network. In the practical working out of a bonding or drainage system two opposing tendencies develop; first, there is a reduction in the difference of potential between pipes and rails in the positive areas, and consequent reduction of damage in those areas; and, second, there is an increase of current flow on the pipes throughout the entire system, thus increasing the danger of trouble at high resistance joints, or other places where two piping systems or separate portions of the same system are electrically discontinuous. As a rule, in the early stages of this system, and especially in small networks when there are comparatively few bond connections, and the resistances of the paths over the pipes are, therefore, relatively high, the effect is apt to be beneficial, reducing the danger in positive areas more than it increases the danger elsewhere. As the system grows and the load increases, more and heavier bonds become necessary. The current on the pipes may finally become so great that the trouble from current shunting around joints, or between separate systems, will increase more rapidly than the danger in the positive areas is reduced, and any further increase in the bonding becomes an actual source of danger to the system. Since bonding transfers the trouble from the region where it was most evident to a new locality where it may require several years to manifest itself, the false impression is created that the trouble has been removed. It is due largely to this obscure manner in which trouble develops that has caused this method to become quite widely used. A number of cases have, in fact, been reported where a main bonded to the negative return circuit at the power station was completely destroyed by electrolysis a block or two away, because of a high resistance joint in the main forcing current to shunt around the joint and leave the main a short distance away from the power station. A case of this kind is illustrated in Fig. 14. In another case, the water main on one side of the street was bonded to the negative return circuit at the power station, and a main on the opposite side of the same street, although connected through cross-piping to the bonded main, was completely destroyed because high resistance joints had developed in the connecting pipes.

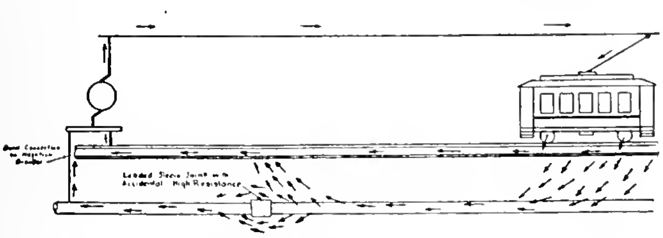


Fig. 14.—Showing Increased Danger from Electrolysis from Bonding Pipe to Rails, Caused by Accidental High Resistance Joint in Pipe.

Among the methods which have been used to minimize the escape of currents on systems using the grounded rails for the return conductor are increasing the resistance between rails and ground, increasing the resistance between pipes and ground, increasing the resistance along the line of the pipe by means of high resistance joints and decreasing the drop in potential in the grounded rails.

The resistance between rails and ground can often be increased by using broken stone ballast, whereby the rails are kept out of contact with ground, and water is allowed to trickle away from the rails, thereby maintaining high resistance between the rails and ground. Where an electric railway owns its own right-of-way, it is frequently feasible, as already stated, to practically insulate the rails from ground.

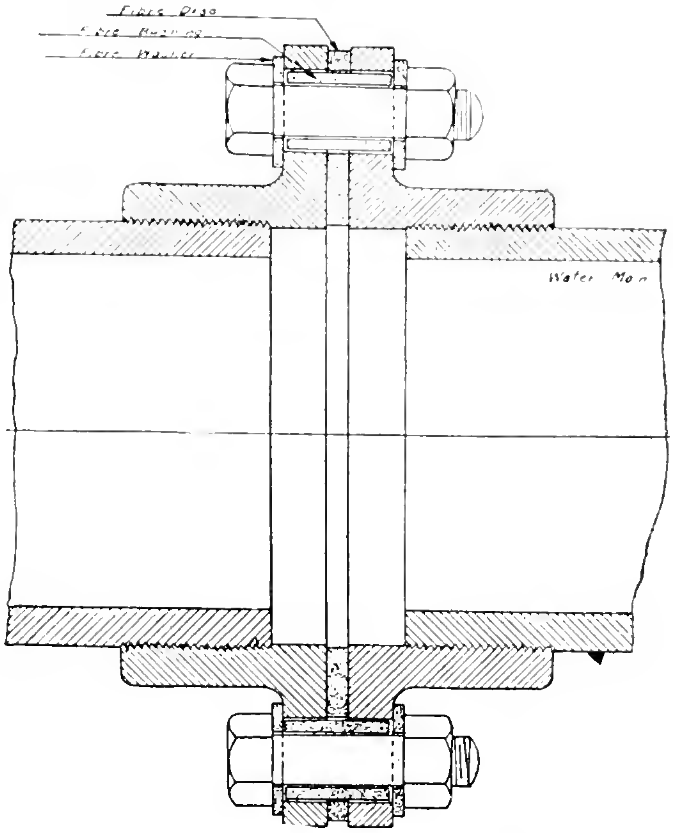


Fig. 15.—Section of Macallen Insulating Joint for Service Pipe.

Attempts have been made to insulate pipes from ground by paints, dips and insulating coverings. Experience, as well as a large number of tests on such paints and dips have, however, shown that no dip or paint will protect a pipe against electrolysis in wet soil. The first difficulty is the mechanical one of applying the paint so as to form an absolutely perfect coating, and then to prevent mechanical damage to the coating. Where imperfections exist or develop aggravated trouble always ensues. Experience further shows that, even where paints or dips are apparently intact and perfect, electrolytic action is not prevented; and, in fact, very serious electrolytic pittings have been found under apparently good coatings. It has been found that in most cases the coatings applied have either been completely destroyed by the effects of the wet soil and the electric currents, or defects in the coating have developed causing concentrated corrosion at such defective spots. The destruction of paints in wet soil, where subjected to an electric current, is due to traces of moisture finding their way through the coating, giving rise to the flow of a feeble current and resulting in a very slight amount of electrolysis. The gas and other products of electrolysis then form blisters and finally rupture the coating. Pipes in positive districts covered with imperfect insulating coatings, are in greater danger from electrolysis than bare pipes. Coating pipes in negative districts with insulating covering does some good in reducing the amount of stray current which reaches the pipes. Where it is attempted to apply a heated material, like pitch or as-

phaltum, to a cold pipe, it is impossible to completely cover the pipe. The only kind of insulating covering which appears to afford certain protection is a layer of at least 1 or 2 inches of a material like coal tar pitch or asphaltum, of such a grade that it is not brittle and so will not crack, but yet is hard enough to remain in place. The best way to apply such a layer is to surround the pipe with a wooden box, support the pipe upon creosoted blocks of wood, or upon blocks of glass, and then fill the space between the box and pipe with the molten material. As a further protection an insulated coupling should be introduced at each end of the section, covered so that, even if the covering should become defective at any point or points, no current can reach the pipe to corrode it by electrolysis. A pipe treated in this way, with the work done so as to be mechanically perfect, would undoubtedly be protected from electrolysis. However, the cost of carrying out such an installation is absolutely prohibitive, except in a few special cases, such as service pipes in very bad localities, or in the case of some very important individual pipe lines of small size. It is not sufficient to apply the covering only in the positive district, nor on the

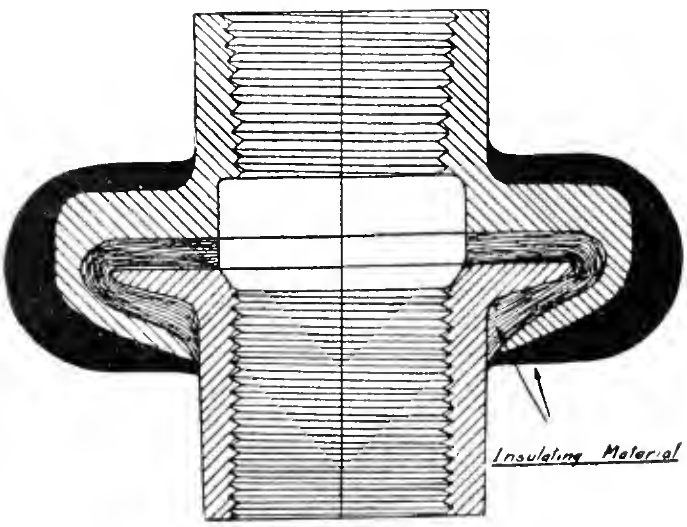


Fig. 16.

other hand, is it always necessary to cover the entire length of line. The portions which must be insulated can only be determined by properly conducted electrical tests. Experience has also shown that embedding a pipe in cement or concrete, even if this is several inches in thickness, does not protect the pipe from electrolysis, and in some cases it has been found that the pipe in concrete is destroyed at least as rapidly as when it is buried in ground.

Current flow on pipe lines can also be practically prevented by using insulating joints for every joint. Cement joints as ordinarily made do not generally produce metallic connection between the two pipes, and may practically be classed with insulating joints. The cause of the high resistance of cement joints is probably due to the fact that, although every attempt is made to push the spigot end home into the bell when laying cast iron pipe, as a matter of fact in most cases the two pipes are not in metallic contact. Even where there is metallic contact this is probably over a comparatively small area, if not at a point. As the end of the spigot is always heavily coated with scale, such metallic contact generally forms a poor electrical connection of comparatively high resistance. It is a simple matter to positively prevent metallic contact by inserting a ring of some cheap insulating material, such as fibre or cardboard, between the end of the spigot and the interior of the bell, and this has been done in some cases. The resistance of cement joints is, then, the electrical resistance of the cement intervening between the spigot and bell, and while cement is not an insulator, but, on the contrary, is probably as good a conductor as ordinary soil, yet, compared with iron, the resistance is so high that the cement joints practically interrupt the electrical continuity of the pipe line. A pipe line laid with all cement joints or with all insulating joints is, therefore, a discontinuous electrical conductor and is not capable of carrying stray electric currents. Such a pipe line, therefore, cannot pick up current in an extensive negative area to discharge it in a restricted positive area, which is generally the cause of the most serious electrolytic danger. For this reason a piping system with all cement or insulating joints is, on the whole, much less likely to be affected by electrolysis than a piping system with all lead or screw coupling joints. Experience has shown, however, that a cement jointed piping system is by no means immune from electrolysis, and there is abundant experience which shows that cement jointed mains, and especially service pipes from such mains, can suffer severely from electrolysis. In these cases the stray currents reach the mains and service pipes from other pipes or by other paths. An example of a gas service pipe from a cement jointed main destroyed by electrolysis from stray currents which reached the gas service pipe from the water piping is illustrated in Fig. 12.

A convenient form of insulating joint for small wrought iron or steel pipes is the Macallen, illustrated in Fig. 15. This is very largely used for insulating water and gas service pipes. A convenient form of insulating joint for large pipes is illustrated in Fig. 16, where a flanged joint is shown with a fibre disc between the surfaces of the flanges, the bolts being insulated with fibre tubing and the bolt heads and nuts insulated with fibre washers. This form of flanged insulating joint has been very largely used for water and gas mains. The Dresser insulating joints are also very satisfactory. Insulating joints can often be used to great advantage in special cases; as, for example, in the case illustrated in Fig. 12, where an insulating joint in the gas service inside of the building would protect the gas service pipe by preventing the current from flowing out of the building on this pipe. Insulating joints on mains must, however, be used with very great caution, as they can under unfavorable conditions do more harm than good. It is sometimes possible to use comparatively few insulating joints to break up the electrical continuity of a pipe line and protect the pipe line from electrolysis, but such joints must be installed only after careful tests have shown that the current is not likely to shunt through ground around them. This depends largely upon the potential gradient through ground and upon the electrical resistance of the ground.

(To be continued).

FORT GARRY HOTEL.

The Fort Garry Hotel, Winnipeg, is the recipient of probably the largest single shipment ever sent from the Amherst plant of the International Engineering Works, Limited. This hotel, which is being erected by the Grand Trunk Pacific Railway is to have a complete power plant furnished by the above company. It will consist of four 300-horse-power Robb-Brady Scotch boilers and three vertical high-speed cross compound engines with two duplex air compressors, smoke connection for the boilers, and auxiliary apparatus. The boilers weigh 32 tons each, are 10 feet in diameter by 17 feet long, with double furnaces 4 feet in diameter by 14 feet 2 inches long.

REINFORCED CONCRETE DESIGN.

The subject of reinforced concrete design and the question of economy in same is well treated by Mr. J. A. Davenport in a paper given before the Concrete Institute of London, England. The following abstract from the above paper gives the conclusions arrived at from the working out of tables presented to the institute by Mr. Davenport:—

Economy in reinforced concrete design might be discussed with regard to: (1) The engineering structure, (2) the architectural structure, and the two sets of conclusions might or might not coincide. The completed engineering structure was a skeleton frame, without any architectural finishes, embellishments, fittings, etc.; while the completed architectural structure was the engineering structure made ready for use and presentable to the eye by the addition of finishes, fittings, embellishments, etc. There were, of course, certain structures such as retaining walls, bunkers, harbor works, etc., which are engineering structures purely and simply, and could not well be considered from an architectural point of view. But it was the object of the paper to deal chiefly with the structures composed of beams, columns, slabs, and walls, which came under the head of architectural structures. The most economical reinforced concrete engineering structure would have a certain arrangement of slabs, beams, columns, etc., with definite percentages of reinforcements, such arrangement and percentages having been determined, with due regard to the loading, with a view of producing the cheapest possible skeleton structure. This result would probably be attained by keeping the slab thicknesses small by the introduction of beams, by keeping beams deep and narrow, and by having the size of columns (probably all different) just sufficient to carry the loads. The adoption of such a scheme would result, as already stated, in the most economical engineering structure; but if they considered the salient engineering points from an architectural point of view, they might find the nett results economical in some cases and very uneconomical in others. Generally speaking, it was economical to reduce the thickness of the slabs by introducing beams and keeping the spans small. Now, it often happens that beams running across ceilings required special finishes, cornices, etc., and the amount saved on the engineering structure might be much less than the extra cost of architectural finishing. The adoption of uniform column sizes might be more economical ultimately, for the same reason. Again, deep and narrow beams were, generally speaking, most economical from an engineering point of view; but they did not conduce to efficient lighting and ventilating, and it might cost more to get these necessary properties than the amount saved on the skeleton structure.

In order to design economical reinforced concrete structures many factors had to be considered, some of which varied in all cases, but there were three fundamental points which influenced all structures in the same way, and these were: (1) The effect of beam section on economy; (2) the effect of percentage steel on economy; (3) the effect of layout or arrangement of beams, columns, etc., on economy.

In dealing with the first factor, the relative economies of singly reinforced T-beams and singly and doubly reinforced plain beams, as regarded the ratio of breadth to depth, were discussed. The meaning of the second and third factors being self-explanatory were not further explained.

The total cost of any reinforced concrete structure, whether a single slab, column, a whole floor, or a complete frame, would be the sum of the total costs of the three items —concrete, steel, and centering—and these, in their turn, would depend upon the unit costs. Now, these unit costs would vary for different parts of the one complex structure, but not for any single member; so that while a mathematical expression for a single member was possible, it would be impossible, owing to the very large number of variable quantities involved, to deduce a mathematical general expression for all classes of structure, simple and complex. Any attempt to deal with the subject of economy mathematically could only lead to ambiguity and vexation. It was, however, possible to deal with the subject by taking different arrangements, percentages, etc., and by calculating the cost of the various items, the required totals could be obtained by summation. That method appeared at first sight to be rather formidable, but by a suitable arrangement of the work it would be found that the difficulty is more apparent than real.

The conclusions might be summarized as follows:—

1. As regards beam section—

(a) Reinforced concrete T-beams, correctly designed, with the total depth three times the breadth of web, are more economical than any other section for all values of unit cost and loading.

(b) For plain beams, reinforced in any way whatever, the most economical ratio of depth to breadth is 3 for all values of unit cost and loading.

(c) For singly reinforced plain beams, the most economical reinforcement percentage runs from 1 to 1.2 for all values of unit cost and loading.

(d) For doubly reinforced plain beams the most economical reinforcement percentage is 1, with equal tension and compression steel, for all values of unit cost and loading.

(e) Plain beams doubly reinforced may be more economical than similar beams singly reinforced, the relative economies depending upon the values of unit cost and ratio of depth to breadth of section, but not to any appreciable extent upon the loading.

The foregoing conclusions were quite independent of any economies effected by adopting uniform sections throughout a design.

(2) As regards percentage of steel—

(f) For ordinary values of unit cost square columns, helically reinforced, are most economical of cost when the diameter of lateral is small, the pitch of lateral is 0.2 the breadth of core, and the percentage longitudinal steel is high

(g) Increased economy of cost will result from the use of longitudinal reinforcement having a lower yield point than ordinary mild steel, provided such material be cheaper than mild steel.

(h) The greatest economy of space is obtained by using large diameter laterals, pitched at 0.2 the breadth of core, and a high percentage of longitudinal reinforcement.

Summarizing conclusions drawn from layout, etc., he states:—

(i) A rational arrangement of slabs and beams supported by columns is more economical than slabs supported by beams only.

(j) A low-percentage slab reinforcement is more economical than a high percentage.

(k) A thin slab is more economical than a thick slab.

The British Columbia Electric Railway Company will spend nearly $200,000 in New Westminster this year. The new freight yards between Fourteenth and Sixteenth Streets, which will have a storage capacity for four hundred and fifty freight cars, will take $100,000, while $50,000 have been appropriated to new car barns. These barns, it is believed, will be the largest in Canada and will be capable of housing nearly fifty interurban cars. The clearing of the site is nearly completed and building will start shortly.

TRANSFORMER AND TESTING PLANT.

The following 60,000 volt testing plant has been designed and constructed by Messrs. Switchgear & Cowans, Limited, of Manchester, for the Union Cable Company:—

The current is taken from the local three-phase supply mains at 220 volts, and is transformed to 2,000 volts single-phase by the transformer shown on the right in Fig. 1. The single-phase current at 2,000 volts passes from the secondary terminals of this transformer to the primary terminals of the Cowan-Still regulating transformer (shown in the circular tank in the centre of the view, Fig. 1). The output of this regulating transformer at the secondary terminals is from zero to 2,000 volts. This feeds in turn the primary circuit of the high-tension transformer shown to the left-hand of the illustration, which gives out zero voltage to 60,000 volts, according as the hand-wheel of the Cowan-Still regulator is operated.

The plant has the advantage that there are no running parts, so that no dirt or dust is produced by its working. The control of the voltage on the high-tension transformer is gradual from zero to full volts, without any steps or jumps. For speed of manipulation the plant leaves nothing to be desired, as it is possible to pass from zero to full volts, or vice versa, in about ten seconds. If the test necessitates that the voltage should be applied suddenly, the article to be tested is connected to the bus-bars, the regulator turned until the correct testing voltage has been obtained, and then the switch shown on the extreme right in Fig. 1 is operated to switch off and switch on as many times as may be required.

The overall efficiency of testing sets of this type is high. In the case in point the alternative suggestion before the Union Cable Company consisted of a three-phase motor-generator taking the 220-volt supply at the motor side and driving a single-phase alternator, the latter being coupled

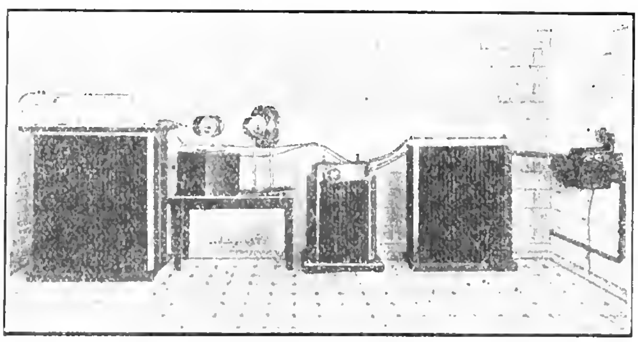


Fig. 1—Testing Plant.

directly to the primary of the high-tension transformer. With a set of this kind, provided with suitable regulators of the ordinary type, sufficient control of the high-pressure testing voltage can be obtained, but although in this case the existing supply at 220 volts three-phase was in favor of the motor-generator equipment, the overall efficiency of the transformer equipment was better. It is claimed that in cases where high-tension single-phase can be introduced directly to the regulating transformer, there is a very marked saving, both in capital cost and also in efficiency, by the use of the transformer equipment.

The capacity of the testing set illustrated is 50 kw. The transformers are made in all sizes, the smallest being of one kw., one of which has, we understand, been recently supplied to a colliery for testing purposes. Testing with a 1-kw. set is usually performed by the regulating transformer only. The makers supply this size of transformer in a circular steel case provided with a lid; the cable connections pass through bushes, and, when made, the lid is closed, and, if necessary, padlocked. The connections are single-phase. If three-phase current only is available, current is tapped off between two phases. The regulator is designed usually to raise the initial pressure to four times its value; thus any voltage may be applied for testing purposes up to four times the working pressure between phases.

Reverting to the larger type, as illustrated, the terminals of the H.T. transformer are arranged in the manner shown in the diagram (Fig. 2), and the connections shown in thick black lines are made by inserting flat copper links into clips. Testing may be performed at 10,000, 20,000, 30,000,

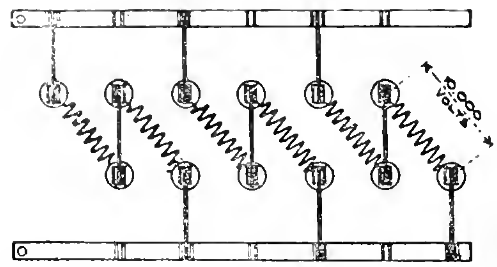


Fig. 2.—High-tension Couplings, Allowing for Combinations from 10,000 to 60,000 Volts.

40,000 or 60,000 volts, and a test may be taking place at 20,000 volts and another one at 40,000 volts simultaneously. For tests of moderate pressure, up to 10,000 volts, six tests may be proceeding simultaneously. At all voltages the operator has complete control by means of the regulating transformer.

The application of this transformer for testing purposes is rather inidental; its true application is for feeder regulation, for which purpose it is highly insulated, is inserted directly into the line of any given feeder, and boosts that feeder from zero to, say, 10 per cent. of the working voltage. The regulating transformer can also be designed to boost positively and negatively. For example, if it is desired to maintain a constant voltage of 6,000 at the secondary terminals of the transformer, a voltage variation on the feeder of between 5,700 and 6,300 may be successfully dealt with by a standard 10 per cent. transformer wound for boosting in both directions.

SASKATCHEWAN ELEVATORS.

According to the figures supplied by the Board of Grain Commissioners, two hundred and forty-three new grain elevators were erected in the province during 1912, giving an increased capacity of 7,064,000 bushels. This number includes those built by the Saskatchewan Co-operative Elevator Company. It will also be seen from the accompanying tables that Saskatchewan has an elevator capacity of over two million bushels more than Manitoba, Alberta and British Columbia combined.

The following table gives the number and total capacity of elevators and grain storage warehouses in Saskatchewan in each of the years 1912-1907:—

Year.	Number.	Total capacity.
1912	1,252	36,503,000
1911	1,000	29,439,000
1910	909	26,440,000
1909	842	24,279,000
1908	638	18,138,500
1907	516	14,621,500

EFFICIENCY OF CONDENSER AIR PUMPS.

In late years, jet air pumps and rotary (whirling) air pumps have been introduced for condenser service. The advantages of this type of pumps are well known, namely, their simplicity, the practical absence of attendance, and the ease with which repairs can be made by substituting a new outfit for the damaged one.

The introduction was facilitated by the shortcomings of the then existing types of reciprocating air pumps. These shortcomings consisted in complications such as mechanically operated valves, with the necessary valve gearing, large clearance and flash ports, the necessity for close adjustment on account of the small width of the flash ports, their sensitiveness for entrained water and the fact that at high vacuum the heat of compression warps the mechanically operated valve, and thereby makes further increase of vacuum impossible. Frequently these pumps were driven by steam cylinders with complicated Corliss valve gear.

Coupled with these features was the general lack of knowledge of the volumetric efficiency of such pumps. In contradistinction to the ease with which tests can be run on jet and whirling air pumps, tests on reciprocating pumps require more expensive installation and equipment.

The old law that improvement in one line produces improvement in a competing line, is true also in this case, and thus we find a new design of reciprocating air pump.

This air pump, which is illustrated by Fig. 1, has no mechanically operated valves on the air cylinder, but has instead automatic valves of the multi-ported plate type (Iverseen patent). There are no flash ports, and no large clearance spaces due to such flash ports. The valves need no attention and no oiling. They open and close at the right time independent of any adjustment.

These valves have been very successful on blowing engines and air compressors. In order to test this type of pump for reliability and economy, it was set up in the works of the Mesta Machine Company, at Pittsburg, and who are placing the pump on the market, and subjected to a thorough test by Prof. W. Trinks, of the Carnegie Institute of Technology. The test rigging is shown in Fig. 2. From left to right there will be noticed the bed plate of the air pump, then the steam cylinder and the air cylinder. The large vessel to the right is simply a tank for converting the pulsating suction of the air pump into a steady flow so that the actual quantity of air taken into the pump could be measured by a standard nozzle. This nozzle will be seen at the extreme right of the picture. Another nozzle was provided at the side of the tank away from the spectator and through this nozzle vapor could be admitted for the purpose of testing the pump under conditions existing in condenser practice. The usual precautions were taken to avoid leakage through the tank, and its joints, and to measure the very small amount of leakage which existed when the valves on the tank were closed. The steam passing through the steam cylinder was condensed at atmospheric pressure in a surface condenser located in the pit under the flywheel. The water resulting from condensing the steam was measured in barrels.

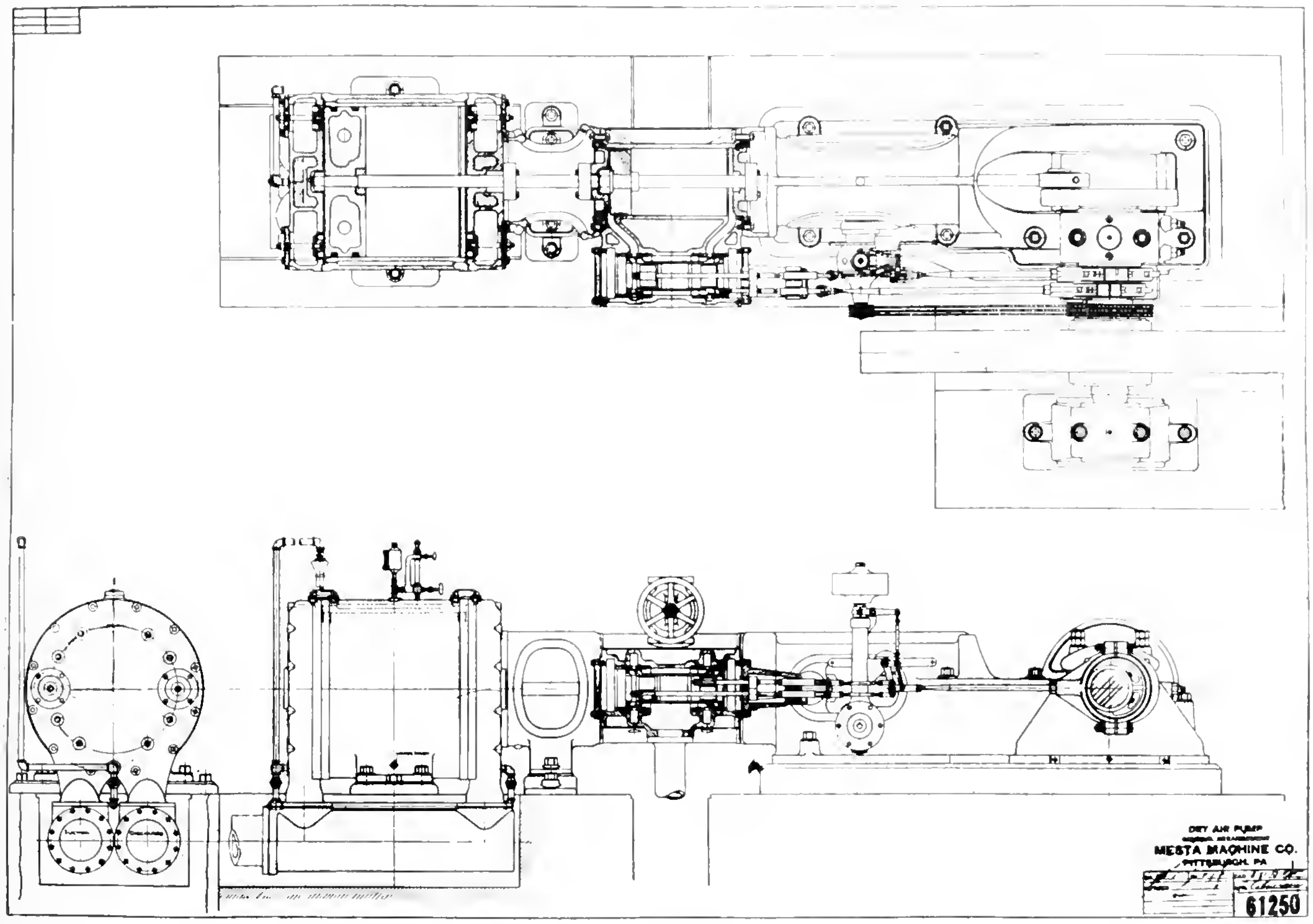


Fig. 1.

In work of this kind, it is not feasible to give the steam consumption per cubic foot of air pumped, because the steam consumption must necessarily vary with the vacuum, with the efficiency of the air pumped, and with the efficiency of the prime mover. It is much better to plot the power consumption of the air pump so as to separate the efficiency of the air pump from the efficiency of the prime mover. For this reason, the ratio of ideal work required for isothermal compression divided by actual work (including all friction work of engine) required, has been plotted against vacuum referred to 30-in. barometer. On the same sheet has been plotted the efficiency of the most advanced type of whirling air pump, as taken from tests published in reliable papers, also the efficiency of whirling air pumps of average type. These latter figures were taken from results furnished by the builders of such air pumps. The illustration shows that for any vacuum less than 29 inches of mercury, the single stage reciprocating air pump is superior to the whirling air pump, and that the difference is considerable for any vacuum less than 28½ inches of mercury. For vacuum above 29 inches, the single stage air pump drops rapidly in efficiency and becomes useless for higher vacuum than 29 1/10 inches. The Mesta Machine Company advises that they are at present building a compound air pump and will furnish test results of that pump in the near future.

The whirling air pumps are commonly driven by small steam turbines whose steam consumption per horse-power-hour is of necessity very high. When it is considered that the reciprocating air pump is driven by a fairly economical type of engine (whose steam consumption per horse-power-hour is approximately one-half of that of the small turbine) the difference in efficiency becomes still more pronounced.

It is not intended to convey the impression that the reciprocating air pump is always superior to the whirling air pump; on the contrary, it will pay in some places to use the whirling air pump in spite of its low efficiency, because exhaust steam is needed to heat the feed water.

On the other hand, the curves on Fig. 3 show conclusively that the reciprocating air pump of the style here described should be used wherever sufficient amount of exhaust steam for feed water heating is available from other sources.

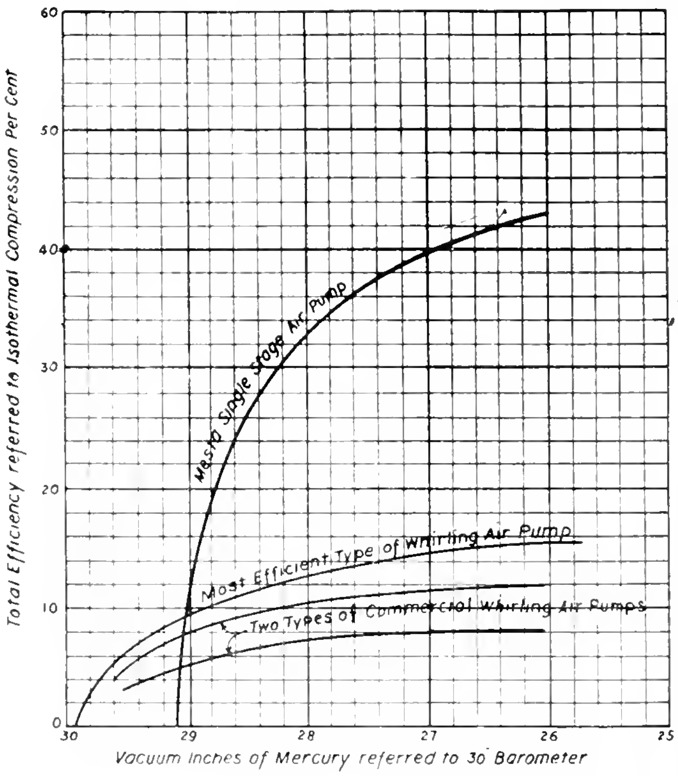


Fig. 3.—Test Showing Efficiency of Air Pumps for Condensers.

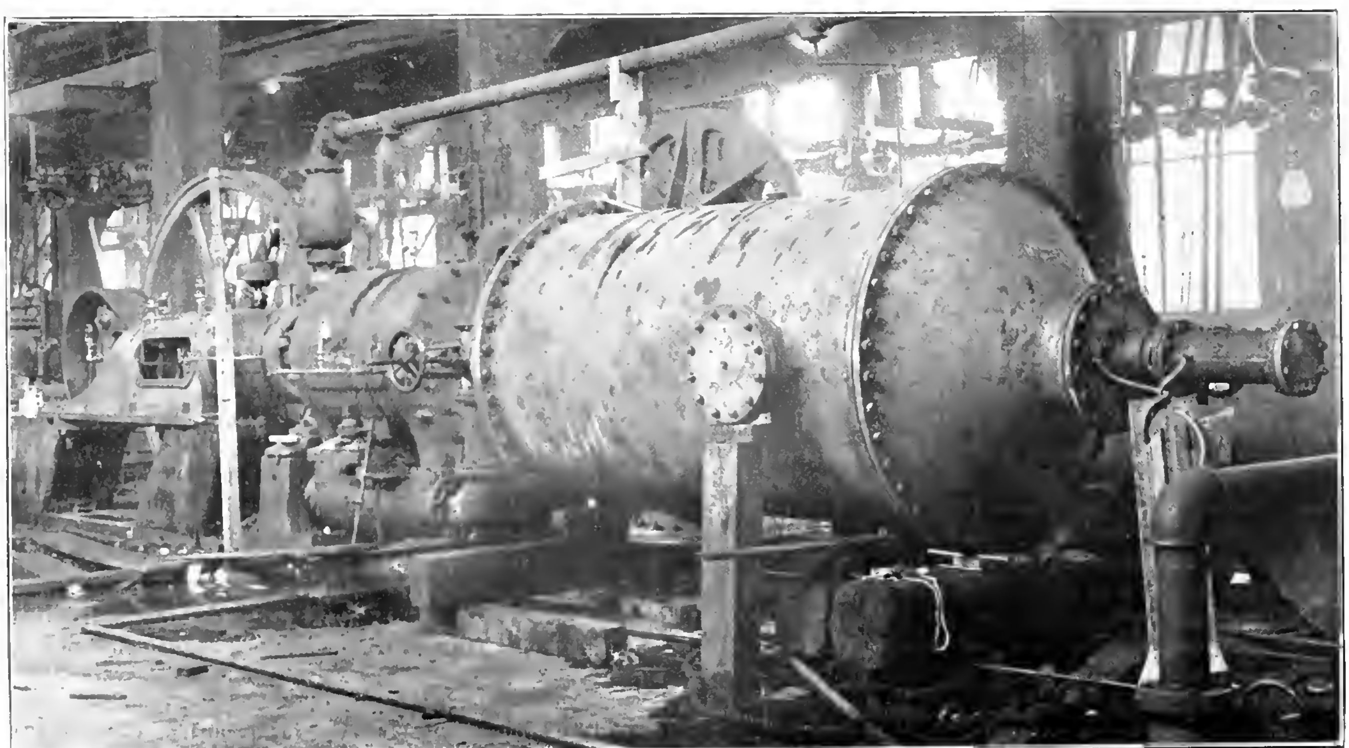


Fig. 2.—Testing Arrangements.

HIGHWAY BRIDGE OVER THE MIAMI RIVER AT ELIZABETHTOWN, OHIO, THAT RESISTED THE RECENT FLOOD.

This bridge is remarkable in being the longest simple-truss span in existence. It has a span of 586 feet between centres of end pins and surpasses in length by 36 feet the longest other span, which is one in the bridge crossing the Ohio River at Cincinnati, known as the Cincinnati and Covington railway and highway bridge.

On the site of the present new steel bridge, there had been for many years an old covered wooden bridge, known locally as "Lost Bridge." It consisted of three spans, 195 feet long each, supported on stone piers and abutments. The old piers were unusually heavy, and yet, notwithstanding this fact, the foundation beneath them was badly scoured, so much so that one had fallen several feet out of plumb at the top. The superstructure of the old wooden bridge was also rapidly failing, the spans showed excessive sag, a condition frequently developing in old wooden bridges before failure. In the summer or autumn of 1903 the superstructure of the old bridge was destroyed by fire, and the need of replacing it at once became apparent.

In selecting the most suitable type of bridge for replacing the old one, there were numerous important considerations. The rise and fall of the water in the Miami River is very uncertain. At flood seasons it rises rapidly, sometimes 20 feet or more in a few days. The greatest difference between high and low water is about 30 feet. At such times the last ten feet or more of rise is back water from the Ohio River. For this reason all bridges in this district are built at about the same elevation of 30 feet above low water of the Ohio River. The railroads and many of the highways are likewise built on banks at the same elevation, for at flood seasons the entire country around is liable to be covered with water.

At another river crossing, about a mile distant from Elizabethtown, the conditions had been met in previous years by building a suspension bridge of 500 feet clear span, spanning the entire width of the water course. The suspension bridge is quite an imposing structure and an ornament to the district, but is lacking in the more important requirement of rigidity. It has a clear roadway of 20 feet and the stone towers at either end are placed 36 feet apart, so the cables have a considerable cradle. It has, also, six sets of stay cables from the towers to the floor, and is braced laterally by three sets of rod guys at each end, fastened to stone blocks on the river bank, yet the passage of ordinary loads, such as farm wagons, causes excessive vibrations. In high, or even moderate winds, the swaying of the bridge is also considerable.

At New Baltimore, Ohio, in the same county, similar conditions had been overcome by building a single truss span 465 feet in length.

The railroads were also having difficulty with their bridges in the same region, and some such bridges were destroyed by having their piers undermined by the scour and wash of the uncertain currents and soil. At the time when the rebuilding of the Elizabethtown bridge was being considered, a railroad bridge in the vicinity was being strengthened and the piers protected at great expense, by having large quantities of broken stone and loose rock deposited around the piers and abutments. It was found, however, that notwithstanding the dumping in of many carloads of rock, and the strengthening of piers with additional concrete, the river piers were still in an uncertain condition and frequently exposed to the damaging influence of scour and the shifting of the channel.

For these reasons it was decided to avoid the use of river piers in rebuilding the bridge at Elizabethtown, and to bridge the entire waterway with a single span. Having thus decided on the use of a single span, approximating 600 feet in length, it then became necessary to select the most suitable type of bridge.

The suspension bridge described above is in some respects very desirable, but on account of its lack of stiffness was not seriously considered as a type for Elizabethtown. The underneath clearance would not permit the use of a deck arch of so long a span, and a through arch, such as those used at Bonn or Dusseldorf, or more recently at Bellows Falls, Vermont, are lacking in lateral stiffness. In through arches such as those mentioned above, it is necessary, in order to maintain the required clearance through the bridge, to omit top lateral bracing between the arch ribs for some considerable distance back from the springs. This is more serious than in truss bridges, where the end posts incline at an angle of 45 degrees or more with the horizontal. With the through arch the slope of the ribs is so gradual that a large part of the most effective lateral bracing between the ribs must necessarily be omitted.

Some forms of stiffened suspension bridge, and a cantilever design of 600 feet span between piers, with back stays similar to the back stays of a suspension bridge, were also considered. None of these forms were favored, chiefly because of their lack of stiffness. Of the alternate forms considered, the cantilever above referred to would doubtless have given the best results. It would leave the waterway entirely free of piers and would permit the use of a narrower roadway, by placing the trusses further apart at the shore, than at the end of the cantilever arms. It is interesting to note that a bridge of this type has since been built at Long Lake, N.Y.

After due consideration of various types, it was decided to use a through, pin connected, simple-truss bridge.

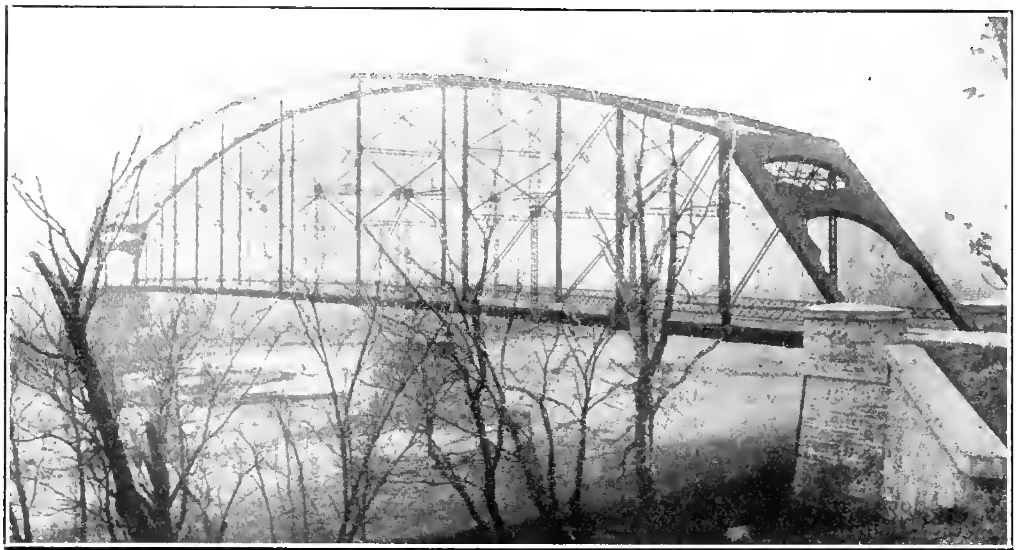
The foundation work consisted chiefly in repairing the old stone abutments by building up new material in reinforced concrete in front of the old stone work, carrying up the retaining walls and parapets, and rebuilding the bridge seats with lines of steel beams embedded in concrete.

The type of truss is the subdivided Pratt, with main panels 65 feet long. The depth of truss varies from 80 feet at the centre to 40 feet at the first panel point. The curve of the top chord is a parabola, in straight sections of two panel length. Stiff laterals and sway bracing are used throughout. This is a very essential feature of the design, and one upon which much of the stiffness of the bridge depends. Lateral and other light struts are built in box form, latticed on all four sides. The first panel of diagonals in the top lateral system are built in the same way. Each of the 32-feet-6-inch panels of the floor system are again subdivided by carrying an intermediate floor beam on two longitudinal beams, one at each side of the bridge. In addition to the benefit of economy in floor framing, the two side beams serve also as chords for the lower lateral system. The longitudinal and cross floor beams are of the same size, and diagonal laterals are rigidly connected by plates, which fasten to the bottom flanges of both cross and longitudinal beams. The floor joist consist of 6-inch steel beams, spaced 2 feet 6 inches apart, elevated on 9-inch beam corbels. On the steel joist is laid the 2½-inch oak flooring, spiked to six lines of 3 x 7 oak spiking pieces, with 60d nails. The wheel guards are 6 x 6-inch oak, beveled on the inner edge and elevated on 4 inch blocks, spaced 2 feet apart for drainage. The bridge was given an initial camber at the centre

of 3 feet. On each side of the roadway there is a neat railing, made of four angles latticed in box form. This railing lines up with the inner face of the web posts and fastens to them.

The two side lines of heavy floor stringers, which act also as wind truss chords, are rigidly attached by means of bottom bracket angles to the main truss posts. Such portions of the wind chord stresses as are not resisted by these longitudinal side beams, are transferred to the bottom chord eye bars, through these rigid connections.

in determining the stresses, was 2,900 pounds. This includes the weight of all steel and lumber, and 300 pounds per lineal foot for snow and ice. The snow load causes no vibration or impact and was therefore classed as dead load. The effect, however, on the web members of a partial snow load, was considered and provided for. Wet lumber was assumed to weigh seven pounds per foot board measure. Seven-tenths of the entire dead load was assumed as acting at points of the bottom chord, and the remaining three-tenths at the points of the top chord.



The Elizabethtown Bridge.

The cross beams, at the panel points, are suspended by two rod hangers 1½ inches in diameter each, from the bottom chord pins, and at the same time they are riveted to the bottom angles on the web posts. This gives a rigid beam connection and at the same time reduces the cost of erection. At one end of the bridge are sets of turned rollers, and at both ends the heavy side beams are connected to the shoe boxes, thereby transferring the wind strains as directly as possible to the masonry. The vertical posts are spliced at the joints of the lateral struts. The minimum thickness of metal used is one-quarter inch.

The metal throughout is medium steel of 60,000 to 68,000 pounds per square inch tensile strength, conforming to the Manufacturers' Standard Specifications.

The assumed dead load per lineal foot of bridge used

The assumed live load was 1,000 pounds per lineal foot of bridge, for the trusses, and for the floor and its supports 70 pounds per square foot of roadway, or a ten ton road roller or wagon. These loads are all in addition to the weight of snow and ice as described above.

The wind load was taken at 30 pounds per square foot of exposed surface.

After the completion of the bridge it was the intention to remove the two river piers, one of which was already leaning over and in danger of falling.

This bridge, which resisted the recent floods in Ohio practically without damage, was erected some years ago. Mr. H. G. Tyrrell, consulting engineer of Evanston, Ill., a graduate of Toronto University, was the chief engineer for the design and construction.

WATER SUPPLY AND SEWAGE DISPOSAL.

The town of Swift Current, Sask., has experienced no little inconvenience this winter owing to the Swift Current creek freezing solid to the bottom. The creek is the source of the town's water supply. Fortunately there was no serious fire in the town while the water shortage existed. Plans provide for a three days' reserve supply of water for the town, and the latter will, by forming an impounding reservoir, prevent any possibility of the source of supply failing on a future occasion. The town of Swift Current is very favorably situated for a gravity supply from a service reservoir, the ground to the south of the town rising to a sufficient elevation to give ample pressure for domestic services.

Plans and estimates for the waterworks are at present receiving the consideration of the Bureau, and if they are approved a by-law will be voted on by the ratepayers, which will include the following works to be executed this year:—

Reservoir	$20,000
Pumping and gravity main	34,500
Water extensions on north side of town	16,500

Plans were recently approved of by the commissioner of public health for a system of water supply, sewerage and sewage disposal for the town of Sutherland. The water supply will be obtained from the city of Saskatoon, the latter city pumping its water from the South Saskatchewan River, and treating it by a mechanical gravity filtration plant. The proposed site for the sewage disposal works is on the south bank of the Saskatchewan River at a point where ample fall is obtainable. Provision has been made for chlorinating the effluent before its discharge into the river.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3 00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, APRIL 17, 1913. No. 14.

CONTENTS OF THIS ISSUE.

GOVERNMENT INVESTIGATION OF ICE CONDITIONS IN THE GULF OF ST. LAWRENCE.

The Federal Government in arranging on the opening of navigation for a patrol service by the Canadian Government steamship Montcalm in Cabot Strait for purposes of ice research and present warning to ocean shipping of ice conditions is tackling in a commendable way the problem of removing from the St. Lawrence route and the public mind an element of doubt and danger which had always haunted those using it. The further recommendation by a committee appointed to investigate the present pilotage system in the Gulf of St. Lawrence, advising a radical change and abolition of present methods, is another step in the same direction.

As regards the research work, the Government has arranged that Prof. H. T. Barnes, of McGill University, with a staff of assistants, shall be on board and carry out further experiments and demonstrations with his microthermometer. Prof. Barnes and his studies of ice problems are becoming so well known in the world of science that it seems almost unnecessary to recall to readers what a boon to shipping Prof. Barnes, in perfecting and developing the microthermometer, has created. In theory it is a very simply designed apparatus. It consists of a coil of wire of approximately 125 ohms resistance enclosed in a metal bulb and placed just below the surface of the water at the side of the ship. This coil constitutes the resistance in one of the four arms of an ordinary Wheatstone bridge. Two of the remaining arms carry constant resistances, the third arm being variable. As the temperature of the water varies the resistance of this coil also varies, so that the temperature of the water is easily calculated from the resistance readings taken.

Last year tests were made with this instrument on the Royal Mail steamship Victorian and Canadian Government steamship Montcalm, and some extremely interesting results were obtained about the temperature conditions found in the immediate neighborhood of icebergs. In every case as an iceberg was approached the temperature increased almost uniformly to the extent of about a degree over a five-mile circle surrounding the iceberg. This rise in temperature was very marked on the microthermometer, and occurred without exception in every set of readings taken as the ship either approached or left a berg. Professor Barnes was satisfied his instrument would detect the presence of icebergs without fail. In view of the success of these experiments it is evident that much added safety would result from the general adoption by all steamships of the device. We hope the present summer's work will still further prove its practicability and utility in northern Canadian waters.

"ETHICS OF ENGINEERING."

Faculties of Applied Science and Engineering throughout the universities of the Dominion are now holding examinations that presage the arrival of several hundred young men after years of study and preparation at the point where they are expected to become engineers in reality and not merely in title. Under the circumstances it is not inappropriate to consider some of the problems of the ethics of the profession which all engineers are bound to have thrust upon them.

Used in a broad sense, an engineer is "one who utilizes the forces of nature in the service of man." Such a definition immediately involves in the word "service" questions of finance which, applicable to man, includes the engineers themselves. Moreover, it does not necessarily follow that in reducing financial remuneration due engineers from the completion of beneficial work that the balance of mankind is even infinitesimally or indirectly benefited. There must be some point at which, if remuneration to an important profession drops, mankind itself becomes the sufferer from deterioration in the type of its followers. In so far as the attractiveness and remuneration of work and working conditions in the engineering profession is allowed to drop below the attractiveness of other important professional occupations there may develop a regrettable tendency for brains and ability to shun engineering paths. There might well be a possible loss both to the engineeing profession and mankind as well.

Many people will uphold that engineers as a body might be said to go further towards overlooking questions of financial remuneration and surroundings affecting themselves than any other organization of their size and importance in the world. Protective organization may not previously have been needed, but with the enormous development and specialization seen in engineering of late years there are signs that some of the profession are not quite as content or satisfied with affairs as formerly. In his inaugural presidential address to the Society of Engineers, England, Mr. Arthur Valon said the development of engineering during the past twenty years had wrought a great change in the personnel of the profession. The requirements for modern engineering training, contrasted with those of twenty years ago, showed that a great increase had taken place in the number of engineers occupying more or less subordinate positions, for which technical competence was a greater recommendation than personal initiative.

Speaking of the organization of the profession, Mr. Valon said that the numerous engineering societies had confined their work almost exclusively to educational matters, and but little attempt had been made to use the corporate strength of the profession to improve the status of engineers. A cental organization for dealing with appointments would be not only a great convenience, but a source of strength to the profession, as it would then be possible to issue warnings against appointments carrying unsatisfactory conditions.

With regard to statutory registration, it was only right that those who had spent time, energy and money in qualifying as engineers should be in a better position than those who had not done so; but before registration could be enforced there were many obstacles to be surmounted, which could be overcome only if the profession were united in desiring statutory recognition, and took steps to present their views in the proper quarter through a suitable organization.

EDITORIAL COMMENT.

The monthly figures given out by the Department of Labor all go to corroborate the need and importance of the present "Safety First" movement amongst railway men. During the month of March, for instance, according to the record of the Department of Labor, 480 industrial accidents occurred, of which 93 were fatal and 387 resulted in serious injuries. The greatest number of fatal accidents occurred to employees in the steam railway service, and of the non-fatal accidents, 115 were steam railway employees. The question of "Safety First" was discussed before the recent meeting of the Canadian Railway Club by Mr. N. S. Dunlop, of the Canadian Pacific Railway. It is a comparatively young movement, and results can hardly be expected immediately, but it is sincerely to be hoped that official figures showing a decided lessening of mortality amongst railway men will soon be witness to the effectiveness of preaching "Safety First." It is the intention to publish in the next issue a portion of Mr. Dunlop's address to the Canadian Railway Club on this subject.

CITY IMPROVEMENT.

While in Montreal Mr. E. E. Culpin, secretary of the City Planning Association, of England, recently lectured to the Civic Improvement League. During his lecture Mr. Culpin stated that the people are recognizing that it is the duty of the city to not only make itself beautiful to look at, but, more important still, beautiful to live in. This means that not only is attention being given to providing pleasing views, artistic public buildings and beautiful parks and gardens, but that the movement is now getting down to the very unit of the city—the citizen. The housing problem is becoming recognized as the one demanding immediate settlement, and the first step toward solving that problem is to secure a comprehensive plan of city making. The systematic planning of cities is not new. There is in existence a plan, drawn 5,000 years before Christ, for a town designed as a dwelling-place for the army of workers engaged in the erection of one of the pyramids. In the flourishing days of Greece and Rome, cities were planned with artistic care, and coming to modern times we have the reconstruction of Paris under Napoleon the Third. Italy was the first country to pass legislation regulating city-planning, while a little later Sweden made it compulsory. Germany then adopted the idea and raised it to the dignity of a science, but it remained for England to humanize it by putting in the forefront the interests and the comfort of the citizen. Some cities have made the mistake of believing that the chief end of city planning is to provide a magnificent centre. The civic centre is a desirable thing, but it should be only the focus for a civic spirit which seeks to improve living conditions for all citizens. Some cities are now spending hundreds of thousands of dollars on civic centres, when the money might much more profitably be expended on better housing.

CANADIAN GENERAL ELECTRIC ABSORBS ALLIS-CHALMERS-BULLOCK.

The shareholders of the Allis-Chalmers-Bullock Company met last Monday and authorized the sale of their assets to the Canadian General Electric Company. The assets include an agreement with the Allis-Chalmers Company, of Milwaukee, which will give the Canadian General Electric Company the exclusive right to manufacture and sell in Canada the Allis-Chalmers lines. These include Corliss engines, gas engines, water wheels and machinery for saw mills, flour mills, mines and cement mills. Business will be conducted under the name of Canadian Allis-Chalmers, Limited, a charter having been applied for. Mr. Milne, manager of the Allis-Chalmers-Bullock Company, will continue as manager of the new company.

THE GRAND RIVER FLOOD CONTROL.

A preliminary report dealing with the possibility of improving the general regimen and local flow characteristics of the Grand River by means of storage and training works, has just been made to the Honorable Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario by Mr. H. G. Acres, Hydraulic Engineer to the Commission. The following is the text of the report:

Through the progressive obliteration of physical influences governing natural control, the flood flow of the Grand River has for some years past been gradually increasing in volume and destructiveness.

Consequent upon this steady increase in flood discharge, the low-water flow has been as steadily decreasing, so that in addition to a large annual loss by flood damage, there has been a material loss through shrinkage in power capacity. The realization that these conditions would tend to become worse year by year, led a number of the interested municipalities to solicit the help of the provincial government in the matter of an investigation for the purpose of devising, if possible, a feasible remedy; such remedy to serve the joint purpose of ameliorating flood conditions and of increasing the power capacity of the stream under conditions of minimum flow.

During the fall of 1912 a reconnaissance survey was made of the Grand River watershed covering the main stream from Caledonia to headwaters; also of the larger tributaries including Whiteman's Creek, and the Nith, Speed and Conestoga Rivers from their confluence with the main stream to headwaters.

The main purpose of this reconnaissance was not to furnish definite data as to the possibility or method of flood control, but rather to eliminate from the problem all portions of the watershed possessing physical characteristics of such a nature as to make more detailed examination plainly unnecessary. With the scope of the investigation thus restricted, it remained to ascertain what locations, if any, merited examination as sites for storage reservoirs and regulating works. The following locations, having the desired characterictics in varying degree, were established:

1. A site between Paris and Glenmorris where by means of a 40 foot dam a storage area of about 1,000 acres would be created. There is also in this vicinity a possibility of controlling about 1,400 acres of storage by means of a 70 foot dam. In both instances the back-water damage would be large, and in the case of the 70 foot dam, would involve the drowning out of several buildings and a considerable length of bighway.

2. A site near the village of Blair where a 30 foot dam would create a storage area about 1,400 acres in extent. The flooded area in this case would be largely meadow land.

3. A site near the town of Elora where a 30 foot dam would create a storage area about 3,000 acres in extent, the back-water damage involving principally meadow land and river flats.

4. Two sites on the Conestoga River, one of which would have a storage area of about 1,200 acres with a 40 foot dam, and the other about 1,000 acres with a 30 foot dam. In the first case, the back-water damage would involve cultivated land and a number of buildings. In the second case, pasture land would be mainly involved.

5. Two sites on the Speed River, one of which would have a storage area of about 600 acres with a 30 foot dam, and the other about 800 acres with a 35 foot dam. The flooded land in both cases would be swamp and poor meadow land.

6. A site on the Nith River near Canning, whe[illegible]5 foot dam would control about 1,100 acres of stor[illegible] back-water damage would be heavy as a number of [illegible]ldings would be involved.

7. A site on Whiteman's Creek near Mount Vernon, where a 45 foot dam would control about 450 acres of storage. The topography of the dam-site in this case would allow the construction of a 60 foot dam, but the back water damage would be very largely increased.

While it is to be understood that the above figures are superficial approximations only, it seems reasonably certain that a system of storage basins as above described would have an aggregate impounding capacity of not less than five billion cubic feet, in which event some beneficial effect through flood control might be expected.

While the information now available seems to indicate that material benefit may be derived from the construction of storage works, the extent of this benefit and the construction cost cannot be even approximately estimated without the help of instrumental surveys and comprehensive hydrographic study.

For the past eight months gauging stations have been maintained on the Grand River, at Brantford, Glenmorris, Blair and Elora. The stations have been so located as to provide information in connection with the characteristics of the main tributaries, and discharge measurements have been made periodically at each station. These measurements, besides recording the flow characteristics of the river under natural conditions and at different seasons, will provide the necessary data for forecasting the behavior of the river under future conditions of regulated flow.

The surveys necessary will involve,—

1. Instrumental determination of channel slope.

2. Detailed instrumental surveys of sites for proposed dams.

3. Surveys of storage basins to establish flood contours, and to determine the maximum possible or permissible limit of back-water.

The data derived from these surveys will provide the necessary information as to the two governing factors of artificial regulation; namely, the obtainable volume of storage capacity, and the extent of back-water damage. If this information proves that material benefit may be derived from the construction of storage works, the next step will be the exploration of foundation material by means of borings and test-pits, after which detailed construction plans will be prepared with estimates of cost.

It may here be mentioned that throughout the Grand River watershed, with the possible exception of that of the Speed River, the topographical features are unfavorable as affecting the height and length of the necessary dams, and the geological features are unfavorable as affecting their foundations. It is, therefore, certain that the creation of storage reservoirs of adequate capacity will entail a large capital expenditure. This expenditure will also be unfavorably influenced by the necessity of providing large spillway and sluice capacity for the safe passage of flood discharge.

Apart from conservation, another important element of flood control is the handling of back-water and the prevention of riparian damage due to erosion. The proper study of the problem under consideration will, therefore, necessitate the examination and survey of restricted channel sections, and of localities favorable to the formation of ice-jams; also a study of back-water effect due to existing dams.

With this information available it will be possible to determine to what extent, if any, flood damage can be reduced by means of channel improvement and the construction of training works.

The final phase of the investigation will be a careful examination of the more remote portions of the watershed to ascertain whether natural run-off conditions will be materially influenced by the permanent retention of existing swamp area, and furthermore, if any benefit might be gained by allowing areas now drained and reclaimed to lapse into their natural state.

In view of the important interests involved, and the practical certainty of a continuous annual increase in the extent of flood damage in the Grand River Valley, there can be no question as to the necessity of an investigation to determine the means by which this abnormal condition can be remedied or ameliorated.

As the solution of this problem will depend primarily upon data collected in the field, and as the investigation so far made seems to indicate that appreciable benefit is to be derived from the works projected, it is recommended that surveys be carried out along the lines above described, and with the least possible delay.

In conclusion, it is important to note that any experience obtained, or evidence of benefit derived from the carrying out of a flood control scheme on the Grand River, could be advantageously applied to several other streams in the Southwestern peninsula which suffer from lack of natural control. Among the most important of these streams are Thames, the Maitland and the Saugeen.

A NEW SPECIFICATION FOR SULPHATE CONTENT IN PORTLAND CEMENT.

A proposed new standard specification for the allowable SO_3 content in Portland cement was recently presented to the International Association for Testing Materials by the German Portland Cement Manufacturers' Association. The substance of the suggestion was as follows:—

Sulphates are found to some extent in all Portland cement, their presence being due, in part, to the raw materials and the fuel used in the manufacture, and partly also to the admixture of crude gypsum (hydrated calcium sulphate) during the grinding process. In a formal analysis of a Portland cement, the quantity of sulphates present is always stated in terms of sulphur trioxide or anhydrous sulphuric acid (SO_3).

The small quantities of SO_3 occurring in normal Portland cement are quite uninjurious to its practical application; and it is only when the amount exceeds a certain limit that during storage under water, a supplementary expansion —which may sometimes be dangerous—occurs in the hardened cement, owing to the formation of calcium-aluminum sulphate.

The permissible amount of SO_3 in standard specifications varies from 3 per cent. to 1.2 per cent., depending upon use in fresh or salt water. After an extensive series of tests, a universal percentage of 2.5 per cent. was strongly recommended for all cases, in view of the fact that it has been shown that the presence of SO_3 is not a vital agent in the deterioration of concrete exposed to sea water, but that this deterioration is due to the penetration of the magnesium sulphate of the sea water into the porous cement mortar. Obviously the way to remedy this is to obtain as compact a mortar as possible in the construction.

An interesting series of comparative experiments has been started by the Royal Laboratory for Testing Materials, Gross Lichterfelde, at the Island of Lylt in the North Sea. These tests are to continue over a period of ten years, and were started in 1907, the materials used being a Portland cement, S, containing 1.19 per cent. of SO_3, and a second Portland cement, B, with 0.57 per cent. Both cements were also tested with their SO_3 content raised to 2.5 per cent. by the addition of crude gypsum.

In considering the tensile values after hardening for one year, it appears that these values are lower throughout in sea water than in fresh water and the open air; and that, in spite of the low percentage of SO_3, cement B behaves less favorably than cement S in sea water. In both cases the raising of the SO_3 content to 2.5 per cent. by the addition of gypsum increased the tensile strength, both in fresh water and in sea water, with the exception of the mixture 1:4 of cement S. This mixture gave a slightly lower value in sea water; but the accuracy of this determination has yet to be confirmed at a later stage of hardening. The results of the tensile tests after one year's hardening show that the presence of even 2.5 per cent. of SO_3 in cement does not have any injurious influence during hardening in sea water.

The concrete blocks made from cement B showed at the end of 1½ years' hardening in sea water (autumn, 1909) such an amount of attrition that the fragments of granite were exposed. The blocks from the same cement with the SO_3 content increased to 2.5 per cent. behaved somewhat better. On the other hand, all the blocks made from cement S had remained in perfect condition. This observation was confirmed in general by the second inspection during the following year, which showed that the cement B, which was alleged to be particularly suitable for marine structures, turned out much worse than the cement S with the higher SO_3 content.

The same conclusion also resulted from the contemporaneous examinations of the plates set up in the mole at the harbor of Munkmarsch. The plates mixed in the proportions 1:2 and 1:4 of cement B exhibited concentric cracks, even at the first inspection, and many of them were burst across the middle: whereas the corresponding plates from cement S were perfect. It should also be noted that the plates made from cement B after raising its SO_3 content to 2.5 per cent. showed less extensive cracking than those made of the cement in its original conditions, i.e., with only 0.57 per cent. of SO_3.

After about three years' exposure of the plates to the influence of sea water, the chemical examination of the plates failed to reveal more than slight alterations due to sea water, in the case of the cement with the higher SO_3 content, whether in its original condition or after enrichment. The cement lower in SO_3 and used in its original condition, was found to have sustained extensive chemical changes under the action of sea water, though only to a smaller extent when enriched to 2.5 per cent. From these results it follows indubitably that the presence of up to 2.5 per cent. of SO_3 in Portland cement produces no injurious effects of any kind, whether in sea water or fresh water.

Moreover, the favorable experience that has everywhere been gained in marine construction works with sements of this kind, namely, containing a higher percentage of SO_3 than is prescribed in countries which issue special specifications for such works, demonstrates that the higher SO_3 content of the cements in question has not led to any injurious effects in practice, provided the cement has been properly used. It is therefore recommended that a uniform permissible maximum limit of SO_3,—namely, 2.5 per cent.—be generally adopted in specifications for Portland cement, whatever may be the purpose for which the cement is intended to be used.

THE MITTENWALD AND RJUKAN RAILWAYS.

A description of the above two single phase railways appeared recently in the February number of The Electrical Review. With the present day tendency towards electric railway construction in Canada, there is no doubt many of our readers will find the abstract of the article we publish interesting.

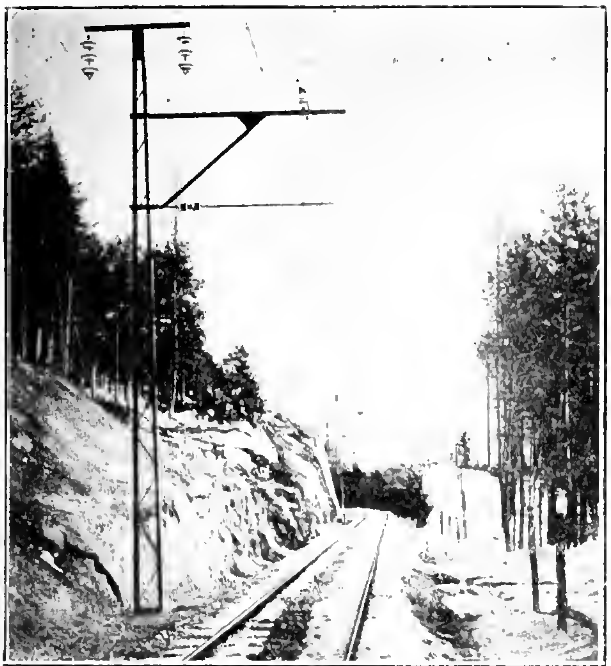


Fig. 1.—Mittenwald Railway, Showing Power Transmission Line.

The Mittenwald Electric Railway.—This railway system is sub-divided into four lines; the eastern line from Innsbruck to Scharnitz, 33 km. long, is frequently referred to as the Karwendel Railway, and, like the western line, 32 km. long, from Reutte to Griessen, passes through Austrian territory; between these lines comes the Scharnitz-Griessen section, which runs through Bavaria and has a length of about 40 km. This curious inter-connection of the sections lying in different countries is, of course, emphasized in the electrical equipment and the arrangement of the service.

On the Austrian sections there are 18 tunnels with a total length of 4,305 metres, one of which alone is 1,787 metres long. In addition there are numerous viaducts and bridges.

The constructional difficulties formed one of the reasons for the selection of electric traction. This, in fact, allowed the railway track to be better adapted to the nature of the ground and permitted a gradient of 36.4 per mille to be used on a large scale; the railway reaches a height of 1,185 metres above sea level at Seefeld, so that in a distance of 21.2 km. a difference of 600 metres has to be overcome. The adoption of steam traction would have necessitated the lengthening of the line by at least 4 km. just at the most difficult part, and the saving effected amounted to more than the total cost of the electrical equipment. Another factor making electric traction more economical is the cheap water power, the Tyrol occupying a still more unfavorable geographical position as regards coal supply than the adjoining country of Bavaria.

The Mittenwald Railway possesses a power station of its own, which is situated about 6 km. to the south of Innsbruck in the vicinity of the Sill Works, and utilizes the power of the Ruetzbach, a river close to the Sill.

In the Ruetz Works two 4,000 h.p. Voith-Pelton turbines have been installed for the time being, which are direct-coupled to single-phase generators with continuous outputs of 3,000 k.v.a. and maximum outputs of 4,500 k.v.a. The turbines and generators have been designed with due regard to the special conditions involved in railway operation, so that the plant cannot be endangered by heavy short-circuits or sudden alterations of load. The generators, which ran at a speed of 300 r.p.m., have six poles corresponding to the frequency of 15 cycles per second, which entails a somewhat higher cost as compared with the four-pole type, but enables the pole cores to be fixed with absolute rigidity to the rotor hub. The generators are wound for a pressure of 3,000 volts, and are self-ventilated, the magnet wheel being fitted with fan blades, and the stator enclosed by covers.

On entering the power station, one is struck by the perfectly noiseless running of the generators. The energy from each generator is led to a transformer which raises the pressure to 50,000 volts; from the point of view of the switchgear, each generator forms a separate unit with its transformer. As there are, therefore, no bus-bars or switches for 3,000 volts, extreme simplicity in switching operations is ensured.

Each transformer has the same maximum output as the generator, the continuous rating, however, is 1,800 k.v.a. The transformers are of the core type with disk windings and have oil and water cooling. The core with its windings is 23 tons in weight. Each transformer is placed in a separate fireproof compartment provided with an effective air circulation; the 50,000-volt switchgear is also enclosed in concrete cells so arranged that the switchroom, in the event of a breakdown, may be entered from two sides with-

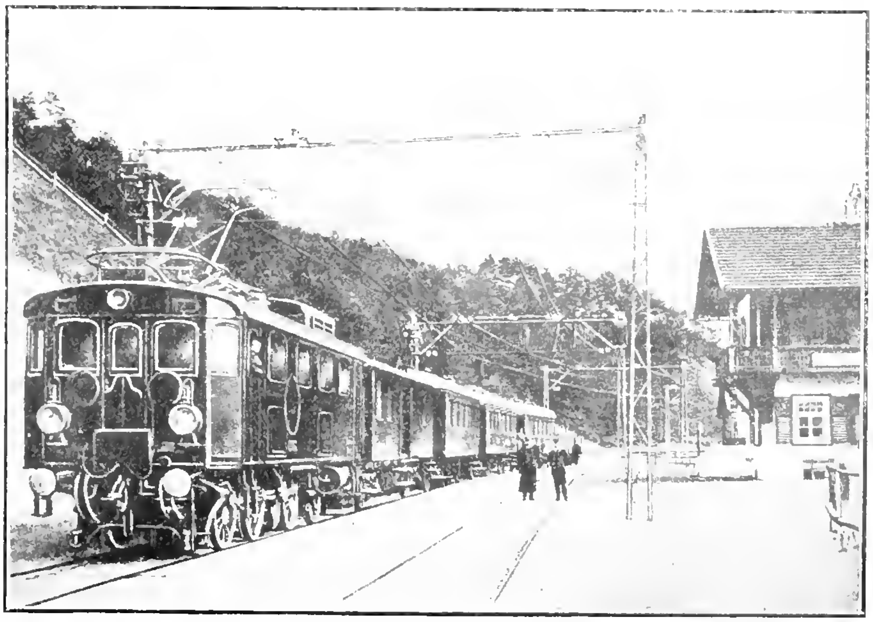


Fig. 2.—Locomotive and Train.

out danger. Switches are only provided on the 50,000-volt side; for the transmission line these switches are doubled.

All switches have electromagnetic remote control operated from the switchboard in the engine-room; they are fitted with automatic overload releases which can be adjusted for a time limit and are also arranged for hand operation. Lightning arresters, excess pressure discharges and choking coils for checking short-circuits are provided.

The energy generated at the power station is carried by a 50,000-volt line to two transformer stations where it is stepped down to the contact line pressure of 15,000 volts.

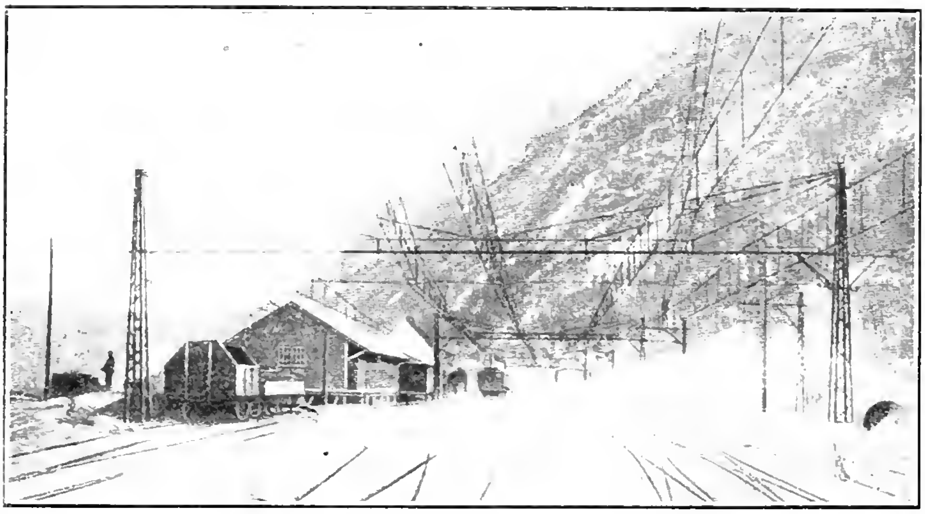


Fig. 3.—Arrangement Contact Line; Rjukan Railway.

The transformer stations, which will also supply current to the Bavarian line pending the completion of the Walschensee Works, are situated at Reith, 19 km. from the Eastern, and at Schanz, 3.3 km. from the Western boundary of Austria.

The transmission line, which is carried mainly on the poles for the overhead contact line, consists of two wires, each having a section of 35 sq. mm. Only the connection between the power station and the railway track (about 6 km. in length) is carried on a separate line of poles.

The first important section of the 50,000-volt line is situated in a desolate district, which is difficult of access in winter; increased care was, therefore, required in its design and construction. On this account, the line in this part consists of three wires, two of which are usually in service, the third serving as reserve to replace a defective wire.

As a protection against atmospheric discharges, a copper earthing wire is mounted above the h.t. line on the tops of the poles, and is carefully earthed to the depth of ground water at each pole. Lattice poles are employed exclusively for carrying the line, and are erected at distances of 80 metres apart; every fourth or six pole will stand firm, even when the line breaks on one side, the intermediate poles being flexible. The 50,000-volt line, for the section from 8.8 km. to 16.3 km. on the Innsbruck-Scharnitz line, has also been erected on a special row of poles, the number and length of tunnels in this section being too considerable for the line to be laid out on the contact line supports.

On account of the transmission pressure of 50,000 volts, which is rather high for Continental practice, special care had to be taken in choosing a suitable type of insulator, as far at least as its mechanical strength was concerned. The overhead line follows a series of sharp curves, and the poles have to stand the jerks produced by the swift motion of the current collectors. Investigation showed that only chain-ling (disk) insulators would stand this heavy stress, no part of these insulators being exposed to traction or inflection strains. The type of insulator ultimately developed by the A.E.G.-Union Co. possesses a breaking strength of 7,800 to 8,000 kg. with a weight of only 2.8 kg. Moreover, it also possesses excellent insulating qualities.

An essential difference between this insulator and those used by American engineers is that the channels are not of circular cross-section and instead of a wire rope exposed to rusting, steel bands applied throughout their width on the porcelain (so as not to injure the enamel) are used to fix it. After fitting the insulators in position, the channels are filled in, thus preventing any water from entering and freezing within the insulator. Another distinctive feature is the flexible armature of the insulator which absorbs all shocks, thus preventing any damage to the enamel.

Chain suspensions, without any automatic tightening devices, are used for the contact wire, which is exclusively carried by lattice poles.

The rolling stock of the Mittenwald railway at present comprises nine locomotives, each of a normal output of 800 h.p. As previously mentioned, the maximum gradient of 36.4 per mile is found extensively on this railway; each locomotive will haul over this gradient a gross train weight of 124 tons at about 30 km. per hour, which corresponds to a tractive effort of about 7,500 kg. What this performance really means will be gathered from the fact that the locomotives during several months' experimental work on the Dessau-Bitterfeld Railway hauled goods trains of 1,100 tons in schedule time over the level track.

Each locomotive, inclusive of the driver and the oil and sanding tanks has a weight of 53 tons in working order.

The current is taken off the overhead wire by two bow collectors each having two sliding sections, and is conducted by a bare high-tension wire arranged above the roof, to a lightning arrester choking coil, and thence into a transformer room where the line is connected up to the h.t. oil switch. The latter has a quadruple break, and includes an extra resistance for reducing any strain produced in switching in the transformer. From the front driver's platform the oil switch is operated directly by the switch lever; from the rear platform it is switched out by a button fed through a series resistance from the controller coil, while a lever system is used for switching in. Between the lightning arrester coil and the oil switch there is inserted a grounding switch operated automatically as soon as the protective cap of the oil switch is removed.

The driving motor is a 12-pole single-phase commutator machine of 800 h.p. normal output, at a speed of 30 km. per hour. It is designed on the A.E.G. system, in accordance with which (contrary to the directly-fed pure series motors), the current in the armature is induced by transformer effects. The rotor winding is, in fact, closed by short-circuiting brushes, thus obtaining the secondary winding of a transformer, the primary winding of which is the field winding of the stator.

Excitation is effected from the rotor, current being supplied to the armature through another pair of brushes from a special exciter transformer connected up in series with

the stator winding. The armature slots are nearly closed, and are arranged slanting to the direction of the axis.

Regulation of the motor speed is effected by altering the supply pressure by means of contractor switches, which are connected up to tappings of the power and exciter transformers, and are actuated by the controlling current. The controlling current is derived from a special (300-volt) coil of the power transformer.

Each of the two controllers has two separate switch-drums, one of which operates the contactor switch of the power transformer, and serves to regulate the power consumption, whereas the other operates the exciter switches, thus controlling excitation. The exciter drum moves the reverser into its proper position in a preliminary stage to "forward" and "backward" respectively. Each of the two switch-drums is entirely self-contained, so that any position of one can be combined with any position of the other, thus obtaining a minimum k.v.a. consumption for each speed of the motor.

Fig. 4.—Tunnel; Rjukan Railway.

The contactor switches are electrically interlocked by auxiliary contacts so that the working of any one group interrupts all the remaining switch coils.

Provision is made for two locomotives to be joined up in multiple connection for hauling train weights of up to 250 tons. This arrangement allows both locomotives to be controlled by a single driver. The conductors for the motor-compressor and the lighting and heating of the locomotives are connected up to the same switchboard with the controller circuit and are fitted with hand switches. All these circuits are fed from the 300-volt controller coil, which has a 19-volt tapping for the lighting circuit. The motor-compressor, which supplies compressed-air for the Westinghouse and Henry brakes as well as for actuating the current collectors, sanders and signal whistles, is thrown into and out of circuit automatically.

Each of the radiators provided for heating the locomotives has an output of 1 kw. Heating sockets are provided at the ends of the locomotives for heating the train, which are connected up to the cars by coupling cables.

The Rjukan Railway.—This is the first standard gauge electric railway in the South of Norway to be installed on the single-phase system. It comprises two sections separated by the Tinn Lake, the northern section (from Saaheim to the Tinn Lake) being the Vestfjorddals Railway, 16 km. in length, and the southern section, about 30 km. long, the Tinnos Railway, running from Tinnoset to Notodden, along the Hitterdals Lake. A ferry across the Tinn Lake will connect the two sections.

The Rjukan Railway is mainly intended for the transport of artificial saltpetre manufactured in Saaheim, to Notodden. Trains with a maximum trailer weight of 290 tons are drawn on the section from Notodden to Lilleherred, which has a constant gradient of about 2.7 per cent. by two locomotives, and on the remaining sections by a single locomotive.

The rolling stock comprises three four-axle, and two two-axle locomotives. The former have two bogie trucks, and are fitted with four alternating-current motors, each having an hourly rating of 125 h.p., and weighing approximately 46 tons. The two-axle locomotives have two motors of the same size, and weigh about 23 tons. The locomotives are constructed for a line pressure of 10,000 to 11,000 volts, 15 to 16 cycles, and are designed for contactor control.

The track equipment consists of a single catenary suspension overhead contact line, the distance between the poles being about 60 metres. On some sections bracket suspension is used, while on others cross-suspension is employed. We illustrate the form of suspension adopted for the overhead line in a tunnel.

The power supply is derived from a separate converter station for each section of the line, only 50 cycles, three-phase current at a pressure of 10,000 to 11,000 volts being available; the converter station feeding the northern section is situated at Vestfjorddalen, and contains two converter sets. Each of these comprises a three-phase transformer which steps down the pressure from 10,000 to 5,000 volts, and feeds an asynchronous motor driving an alternating-current generator with an output of 400 k.v.a., which supplies the line. The converter station receives its energy from the Rjukan power station, which is about 5 km. distant.

The southern section is fed from the Svaelgfos converter station, which is situated in the same building as the power station and consists of three converter sets similar to those above described.

MUNICIPAL OWNERSHIP SUCCEEDS.

Municipal ownership of public utilities in Edmonton resulted in a net surplus of more than $60,000 during the twelve months ended October 31st, 1912, according to the annual report of City Auditor Richardson, submitted to the council at its last meeting. The report shows the city has assets valued at $15,982,205, the assets in cash totalling $642,095. There was a net deficit of $10,033, due to over expenditures. There is $2,021,162 in unexpended debenture funds on hand, against which there is an allowance of $600,000 for the city's share of street-paving and sewer construction. Debentures authorized and unsold amount to $1,267,260. The principal surpluses for the year are given as follows: Electric light and power, $85,656.75; power house, $13,311.60; telephone department, $4,324.63. The deficits, largely as the result of over-expenditures for construction and betterment, are: Street railway, $32,549; water department, $3,064; stores and works department, $8,618.

ADVISORY ROADS COMMISSION FOR NEW YORK STATE.

The following individual report of Mr. Eugene W. Stern, consulting engineer, Park Avenue and 41st Street, New York, made to the governor of New York State, on March 31st last, will be of interest to members of the engineering profession. We present herewith the full text of the report:—

The Advisory Commission on Roads was appointed by you on February 21st, to report to you on the following matters in connection with the building of highways in the State of New York, namely:

(1) To advise as to the proper organization and administration of the Department of Highways.

(2) To assist in the selection of a Commissioner of Highways.

(3) To gather information and make recommendations regarding the construction and maintenance of highways.

(4) To make such other recommendations as we may deem desirable, affecting the construction of highways in New York.

After carefully considering the report of the majority of the members, I find that it does not express with sufficient clearness and force, my views on some of these matters, and I, therefore, report to you as follows:—

Organization and Administration of the Department of Highways.—It is a prevalent idea with the public that the construction and maintenance of roads is a very simple matter requiring only ordinary business ability; whereas the facts are that in no department of public works is there greater opportunity for the exercise of sound engineering principles, technical knowledge of the subject, and true economy than in the building and maintenance of roads. A very great deal of money is being wasted every year by the road departments of many of our States in ignorant and useless experimentation on road materials, and methods that have been tried out and long ago abandoned by engineers experienced in this kind of work.

Highways in New York State will never be properly and economically constructed and maintained unless a thoroughly efficient engineering department be organized in connection therewith.

The Murtaugh bill, reorganizing the Department of Highways, which has just become law, unfortunately has grave defects, both in the entire scheme of organization, and in the small salaries attached to the principal positions, which defects, unless corrected, would seriously hamper any honest endeavor to thoroughly organize the department on an efficient basis.

My criticisms of the existing law are as follows:—

The commissioner is not required to be a civil engineer, nor one who has had experience in the construction of Engineering works, nor in the organization of engineering departments. The law would permit a layman to fill this very responsible position. If a layman were chosen, the engineering organization is not properly planned to be efficient, nor to attract to it the right kind of men. There should be under the commissioner a chief engineer of the highway department who should be directly responsible to the commissioner for all the engineering work and, therefore, should have full charge and responsibility in the preparing of plans and specifications, execution of the contracts, and of the carrying out of the work, likewise of the maintenance of all roads which come under the jurisdiction of the department.

The chief engineer should have the right to select his staff, consisting of three assistant engineers and nine division engineers, subject to the approval of the commissioner.

In such an organization, the commissioner would be able to hold the chief engineer entirely responsible, and the latter could not then complain about the division of responsibilities which the law permits in which the chief deputy is really no more than an engineering advisor to the commissioner, and has not any real responsibility or authority in the actual execution of the work, having absolutely no control over the division engineers, who are in actual charge of construction, nor over the second and third deputies, who have entire charge of the maintenance and repairs of all roads.

The bill as framed is not sufficiently exacting as regards the qualifications necessary for the so-called deputies, and limits the selection from among those who have had practical experience in construction and maintenance of highways. The bill is very weak in the use of these qualifications, which would permit a man who had been in such a position as foreman over a gang of laborers employed on road work to become a deputy, with all the great and highly important responsibilities which attach to the office. Furthermore, it would limit the field of selection to a small body of men. I would recommend that railroad engineers be eligible for appointment, as the experience in grading, construction of bridges, foundations, drainage, etc., gained in railroad construction is applicable to the similar problems met with in highway construction, and a thorough knowledge of organization and of the handling of men, and of business methods, a thorough practical training in construction, and zeal and efficiency, are among the qualifications of a successful chief engineer of an important railroad. The only qualification he might be lacking in would be experience in the proper surfaces for highways, but given the power to obtain advice from consulting engineers who have had special experience on this subject, it is reasonable to suppose that a competent chief engineer from one of our prominent railroads might be an ideal selection.

The compensation for the heads is altogether inadequate to attract the proper kind of men to this department. The commissioner should receive a salary of about $15,000 a year, the chief engineer of about $12,000 a year, and each of the assistant engineers, $6,000 a year. This increase over the salaries allowed in the Murtaugh bill, amounting in all to only $19,000 a year, ought to enable the State to obtain the services of men who are eminently qualified to fill such very responsible positions.

The law requires that inspectors of construction shall be selected from residents in the country in which the highway constructed or improved is located. While preference should be given to residents, we do not believe that this should be mandatory, as very often the appointment of non-residents might be found desirable or necessary, and be decidedly better for the efficiency of the service.

The chief engineer, the three assistant engineers, and the nine division engineers should not come under civil service requirements, as these men should form part of the official family of the commissioner, and be removable by him at any time for the good of the service.

Selection of a Highway Commissioner.—The selection of a proper person for the office of commissioner is most important. No matter how good the scheme of the reorganization of the department of highways may be, unless a wise selecion for the position be made, radical reform will not be effected.

Instead of naming particular individuals for this place, it would seem to me to be more important that the kind of man who would best fill such a very responsible position be indicated.

The commissioner should be a man of such high character and standing as to command the respect and confidence of the public at large. He should be of proven executive ability, with a thorough knowledge of how to organize such a department, and be chosen from the engineering profession if possible, otherwise he should be one who has had to do with the construction of engineering works.

Types of Roads.—The particular kind of a road to use in a certain locality is a problem which depends for its proper solution on a number of important factors, such as the kind and amount of traffic, the sub-soil, the climatic conditions, the cost of construction and maintenance, and the amount of money available for construction and maintenance. It would be entirely out of place, therefore, to recommend any particular types of roads, beyond calling attention to the fact that there are two fundamental requirements which are accepted as axiomatic by all who are authorities in road building, namely, that in all cases there should be perfect sub-drainage and a rigid foundation. There is no need for extensive experimentation in the near future on the part of the State of New York as to what kind of roads to build, for so many methods have been tried both at home and abroad that intelligent investigation of what has been already done would be sufficient to indicate what types of roads and road surfaces should be eliminated from consideration, and what types are best suited for particular localities.

It will doubtless become advisable from time to time to experiment with new types, but this may be done on a small and inexpensive scale. A short stretch, say, of a few hundred feet, will give just as valuable data, as regards durability, etc., if careful and intelligent observations are made, as many miles.

In connection with this problem, it is important that we recognize the fact that the difficulty of providing durable roads has been greatly augmented by the introduction of automobile traffic; the wear and tear resulting in their use being much greater than from horse vehicles, and that we must make up our mind to make much more durable types of roads than we have been accustomed to in the past.

There can be no doubt but that the rapidly moving automobile and auto truck have come to stay. This method of transportation is yet in its infancy, and before another generation, if proper roads shall have been provided to take care of it, the economic benefit to the community, resulting from their use, will be of great value.

Another important consideration which should not be lost sight of is the fact that the money to construct the new roads in this State is raised by bond issues, maturing in fifty years from the date of issue. It would be manifestly unfair, therefore, to future generations, to construct roads with this money that last only a few years, if more durable types requiring less annual expenditure for maintenance are economically practicable.

Maintenance.—The proper maintenance and repair of existing roads is just as important as the construction of new ones. England, France and some other countries of Europe, are far ahead of us in the thoroughness and efficiency with which they keep up their roads.

It is most important that the Department of Highways should be thoroughly organized for this purpose, so that repairs may be promptly, economically and efficiently made, for by promptly repairing small defects, not only is the road made better for constant service, but the cost of maintenance is decreased.

The amount allowed in the budget for maintenance should be sufficient to avoid any delays in making immediate repairs.

Additional Recommendations.—In addition to the foregoing, I make the following recommendations on matters not yet touched upon:

Existing contracts for roads which are undesirable should not be executed, but cancelled wherever possible.

New contracts should not be let until the commissioner shall have been able to thoroughly organize his department, and investigate the plans and specifications which are now adopted by the department as standard types of construction, and he should, of course, be given ample time to prepare revised plans and specifications.

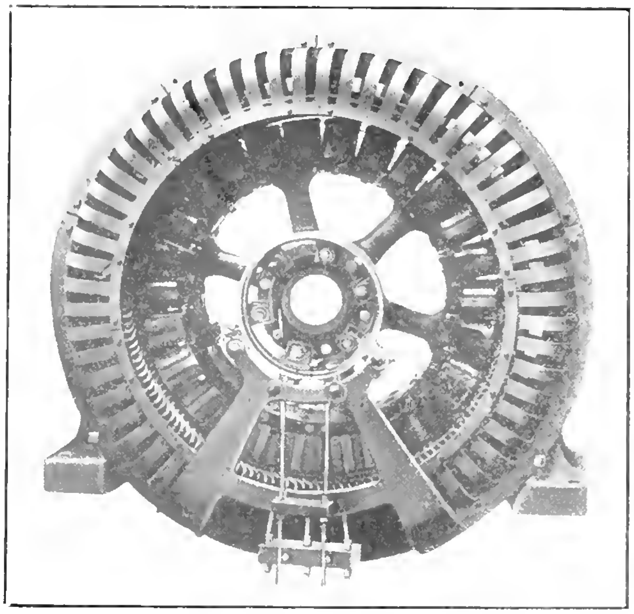
Supplementary agreements, radically changing the character of construction in work contracted for, should be avoided.

Specifications should be revised and should clearly describe the work to be done, and there should be a uniform interpretation of them by the department.

A thorough study of the highway map of the State should be made without delay. It should be revised where necessary, so as to unite the present State and county highway systems

SYNCHRONOUS MOTORS FOR DRIVING COMPRESSORS.

The use of synchronous motors for driving compressors is comparatively new practice. A few years ago the synchronous motor was not considered well adapted for this service but recent improvements in the design of these motors have entirely changed this view. To-day synchronous motor drive is used for many compressors in various parts of the country, and it has proved so efficient and reliable that the fact that this type of drive is the most satisfactory for this service can now be considered established.



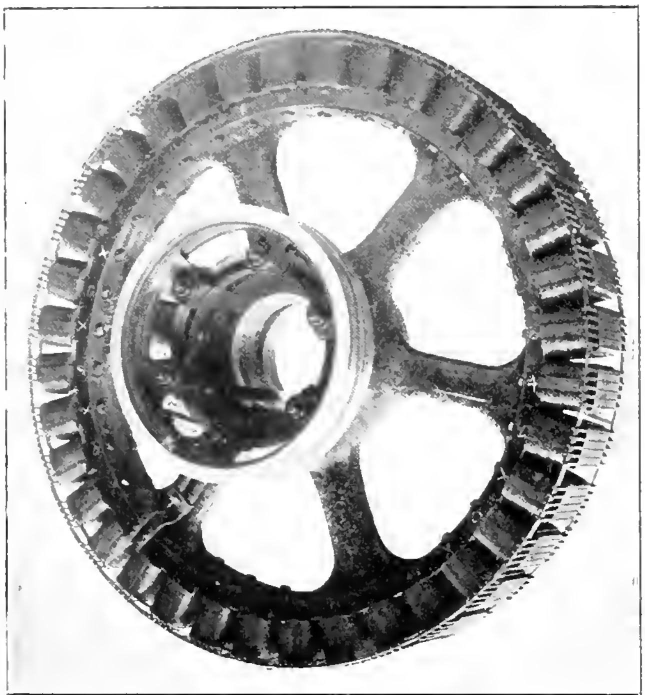
Synchronous Motor.

A typical example of this kind of utilization is furnished by the compressors at the Wickwire Mining Company's mines at Iron River, Mich. There are two compressors on this property, each driven by a Westinghouse self-starting synchronous motor. Both compressors are of Ingersoll-Rand make; one delivers 1,352 cubic feet of free air per minute at 200 r.p.m. and is driven by a 220 horse-power mo-

tor, and the other delivers 995 cubic feet of air at 235 r.p.m. and is driven by a 175 horse-power motor. These compressors have been in operation over a year and have proven very satisfactory.

As compared with other forms of drive for large compressors, synchronous motors possess a number of advantages. In the first place, the first cost of a synchronous motor compares very favorably with that of other types of motors or engines. The motor is especially adapted for direct connection, so that it costs less to install and takes up minimum floor space. The illustration shows what a compact unit is formed. The elimination of belts also decreases the maintenance expense.

The reliability of these motors in this service is proven beyond question. There are a number of installations which have been giving perfect satisfaction for a long time. A notable instance is that of the Anaconda mines where a total of 7,200 horse-power of Westinghouse synchronous motors have been driving compressors for nearly four years without a hitch, in spite of very variable operating conditions.



Synchronous Motor.

One of the chief objections to the old type of synchronous motor was the fact that it required some auxiliary starting device, but this difficulty has been eliminated. The modern synchronous motor is self-starting and self-synchronizing.

Another advantage of the synchronous motor is its ability to operate at 100 per cent. power factor, which tends to improve the operation of generators and to increase the capacity of transformers and transmission lines. If desired, these motors can be arranged to raise the power factor of the entire circuit by being supplied with excess capacity and used as synchronous condensers; thus greatly increasing the operating efficiency of the generating and transmission system.

The synchronous motors used at Wickwire represent the most modern design. They are characterized by great strength and simplicity of construction, as the illustrations show. The stator is supported by a heavy cast iron frame, and the coils are form wound and so arranged that they can be easily removed and replaced if the necessity ever arises. The rotor consists of a cast iron spider which carries the field poles. The windings are so arranged that they receive ample ventilation, and each field coil can be easily removed. An interesting feature of the rotor is the squirrel cage winding that encircles the field poles. This winding makes the motor self-starting and eliminates "hunting," or surging, which was one of the disadvantages of the early type of synchronous motors.

The Wickwire mine is operated from 6,600 volt, 60 cycle, three-phase power supplied by the Peninsular Power Company. This voltage is stepped down to 2,200 volts for the synchronous motors, and 220 volts for the motors for driving pumps and other apparatus.

THE IGNITION OF MINE GASES.

"The Ignition of Mine Gases by the Filaments of Incandescent Lamps," is the title of Bulletin No. 52, which has just been issued by the United States Bureau of Mines.

The authors, H. H. Clark and L. C. Ilsley, make the following general statement:—

As part of its investigations of the causes of mine accidents and of the safest and most efficient methods of handling electricity underground, the Bureau of Mines undertook a study of the ignition of mine gases by the filaments of electric incandescent lamps. This bulletin describes the investigation in detail and gives a complete record of the results obtained.

The investigation was undertaken for the purpose of determining the degree of danger that attends the use of certain specific sizes of incandescent lamps in atmospheres containing inflammable gas. Previous investigators have, to a greater or less extent, been concerned with certain theoretical features of the problem, such as the effect of the temperature and the dimensions of the lamp filaments; and the question whether a lamp may ignite gas by the heat of its glowing filament or by the spark that is drawn when the filament is broken. Although these features were considered in the present investigation and are briefly discussed in this bulletin, the principal object of the tests was to determine what sizes of incandescent lamps suitable for mine use would ignite explosive mixtures of mine gas and air, and what were the circumstances most effective in causing such ignition.

The results of the investigation may be generally summarized as follows:—

The naked carbon filaments of standard lamps, burning at rated voltage, will invariably ignite explosive gaseous mixtures.

If gas can reach the filaments of standard lamps without breaking the filaments of producing partial combustion within the bulbs, the explosive gaseous mixture is sure to be ignited.

Several sizes of both standard and miniature lamps, when smashed while burning at rated voltage, will ignite gas.

Standard lamps that do not usually ignite explosive gaseous mixtures may do so if the broken pieces of the filament cause a short circuit when the lamps are smashed.

Copies of this bulletin may be obtained by addressing the Director, Bureau of Mines, Washington, D.C.

SEWAGE DISPOSAL.

A report which speaks of the satisfactory working of percolating filters with granite chips as a medium was recently issued by the borough surveyor of Nuneaton, England. The quantity of sewage dealt with during the year was 425,590,000 gallons, which represents a daily average of 1,106,000 gallons, and is about 110,000,000 gallons in excess of the quantity treated in 1911.

The increase is mainly due to the heavy rainfall throughout the year, for many millions of gallons of sewage were pumped for treatment at Hartshill, which, under the old conditions, would have passed into the river direct from the sewers, and would have polluted the stream to this extent.

Of the 402,100,000 gallons treated at the Hartshill outfall works 340,751,000 gallons were dealt with by the filters, and the remaining 61,349,000 gallons by the primary contact beds and subsequent land irrigation. The effluent from the filters was at all times capable of supporting fish life in the outlet channels of the humus tanks, and was therefore discharged direct from the humus tanks into the river.

The seven primary contact beds were filled in the aggregate 7,708 times, equal to a daily average of three times each. The average liquid capacity was 45,900 gallons, as compared with an original capacity of 75,000 gallons, equal to a loss of 38.2 per cent. after eleven years' working. In the previous year the average liquid capacity of the primary beds worked out at 40,690 gallons, so that there has been an increase in capacity of 5,210 gallons per bed. The increase, in the opinion of the borough engineer, is probably due to the fact that the beds were worked more as balancing tanks for the percolating filters than as contact beds; consequently the period of quiesence was often materially less than the two hours generally allowed, and there was not the same opportunity for the deposit of suspended matter.

The last of the seven secondary beds converted into percolating filters was brought into use in May, thus completing the work of reconstruction commenced two years ago.

The continued satisfactory working of the percolating filters is the most gratifying feature of the works. Despite the fact that the medium in each filter consists of fine granite chippings with a 2-ft. 6-in. depth of ½-in. gauge at the surface, it has not needed cleansing in any way. The whole area of 1¾ acres is quite free from ponding. The clean condition of the medium is mainly due to the separating tanks with upward flow roughing filters, which were installed in connection with the recent extension of the works. The total area of the roughing filter in these tanks is only 54 sq. yds., but they have been thoroughly successful in the elimination of such suspended matter as has passed through the silt tanks.

Having regard to the success which has attended the conversion of the secondary contact beds into percolating filters, as well as to the continued increase in the flow of sewage, it has been decided that the primary beds shall be gradually dealt with in the same way. There is always a surplus of chippings produced at the quarry, and these will be utilized as they accumulate for this purpose. Very little expense will be incurred for ironwork until the filling of each bed is completed and it becomes necessary to fix the distributor, the cost of which will be about $3,000. The expense will be almost entirely in respect of superseding old work, so that it will be properly a revenue charge, and will not be felt so much as in the case of work executed under more rigid conditions. Each filter so provided will be capable of dealing with about 150,000 gallons per day.

CANADA'S RAILWAY TRANSPORTATION.

Prof. S. J. McLean recently delivered an instructive lecture on "Transportation" before the Canadian Club at Pembroke. He stated that the first railroad in Canada was built about 1838, and had wooden rails, and the motive power was horses. In 1868 there were 2,200 miles of railway in Canada; in 1878 there were 5,200 miles. This year there are about thirty thousand miles, or about the same as in Great Britain and Ireland. Last year 2,300 miles were built, or as much as between the years of 1836 and 1867. There are 8,000 miles under construction now, and about three-quarters of this is west of the Great Lakes.

In 1912 the average construction was four miles a day. Of the actual money gone into railways in Canada, 25 per cent. comes from the various provincial governments and the Dominion government, and the land grants, etc., amount to 17 per cent. more. Besides this, large amounts of the railway bonds are guaranteed.

In proportion to its resources, no other country contributes so liberally. There are such great developments west of the Great Lakes that very often the railroads cannot keep up with the advance. Last year 13,000 people went through Edmonton to the Peace River district, where they must work along as best they may until the railroad reaches them, some of them carting in their grain sixty-five miles over bad roads.

The formation of a railway commission was first taken up in Canada in 1860, and in 1880 Dalton McCarthy brought the matter to the attention of Parliament. In 1886 a Royal Commission was formed to conduct an investigation re changes of the general policy of the Railways Act, and in 1888 it was recommended that the commission be given power to deal with matters concerning preference and discrimination.

In 1904 the present commission was organized. The three central matters for their consideration are safety, service and rates. It is composed of six members, three members forming a section empowered to act so that two sections may act at once in different places.

There are three general departments: engineering, operating and traffic. They have a staff of five engineers, who are constantly on the road investigating railway matters, and they also have a staff of men to look after every department of railroad workings. Every working day the commission has 238 tariffs to consider, both local and international. For every case dealt with formally, there are six or seven dealt with informally. The cases coming before the commission involve items of from 15 cents to hundreds of thousands of dollars.

Three-quarters of the decisions of the commission are oral, being given immediately after the hearings. There were 609 decisions for the year ending in April, 1912. The commission is a perambulative body, and tries to get as close as possible to the individual complaint. The business of the commission is sane regulation, not management.

CANADIAN NORTHERN BUSY.

Work is in full swing on the Lulu Island branch of the Canadian Northern Railway running from the west boundary of New Westminster to Steveston at the mouth of the Fraser. The contracts, sub-contracts and station contracts are now being let and the grade will be completed by the beginning of June.

LARGE PAVING CONTRACT AWARDED.

Approximately $1,800,000 was voted recently by the Detroit, Michigan, city council for new pavements, and of this amount about $906,000, almost exactly one-half of the total, was earmarked to be used for paving with creosoted wood blocks. The remainder was divided among asphalt, granite and other types of pavements, about $400,000 being devoted to sheet asphalt.

Tenders for the supply of creosoted wood block were called for a few weeks ago. A special despatch to *The Canadian Engineer* last Monday announced that the Detroit city council had met and awarded the contract for the entire $906,000 worth of wood block paving to the United States Creosoting Company, of which the Canada Creosoting Company, whose plant is at Trenton, Ontario, is a branch.

A thorough investigation of paving materials was made in the year 1911 by the Detroit Board of Commerce. Foundations, manner of laying and methods of testing were studied, as well as every criticism that was advanced by the manufacturers of the various paving materials.

An interesting booklet announcing the results of the investigation has been issued under the title of "A Message from the Business Men of Detroit Regarding Their Pavements." Copies of this booklet will be sent to interested persons on request by the Canada Creosoting Company, Canadian Pacific Building, 1 King Street East, Toronto.

The first creosoted long leaf yellow pine wood block was laid in Detroit in 1905, and since then about 320,000 square yards have been laid. The only appropriation asked for the maintenance of the entire 320,000 square yards was $500, allowed in 1912. The specifications now in vogue in Detroit call for a 3½-inch block, with twenty pounds of creosote oil to the cubic foot. No guarantee deposit fund is required from the manufacturers, as past experience with the block has been so satisfactory that no charge could be made against such a fund.

The large demand for wood block came principally from property owners, not only in the downtown section but also in the residential section. There are now between sixty and seventy streets in Detroit laid with wood block, over seventy per cent. of the work being done by the city with its own men, under the title of resurfacing work. Some interesting data is given in the booklet above mentioned regarding just what wood block pavements are, their advantages, method of inspection, etc. The following quotations from the booklet are interesting:—

"For wood block pavements the favorite wood is yellow pine. To prevent decay, the wood blocks, after being cut, are placed in a cylinder and impregnated with creosote oil by a thorough vacuum process, which drives the creosote to the heart of the wood. The creosote, being a perfect antiseptic, makes the wood immune from wet rot or decay of any kind.

"The blocks are laid in the pavement on a foundation of concrete. The concrete is brought to a smooth surface by a coating of mortar or by the spreading of a sand cushion. The blocks are laid with the grain vertical with a tight joint and brought to a uniform level by tamping.

"The first effect of traffic on the wood block pavement is to broom the edges of the wood slightly, thus closing the joints and making them practically invisible, except near the curb where there is less wear. In consequence, wood block pavements frequently are mistaken for sheet asphalt.

"During the first year, traffic hammering upon the end of the grain pounds it down and mats the fibre, thereby reducing the total depth of the block by about one-eighth of an inch. The blocks cannot splinter or split because each block is imprisoned by the adjacent courses and has no room to spread. The wood does not wear away because of its resilient and fibrous nature. As a result of this hammering, the surface gets so tough that subsequent traffic has no effect upon it and during the next ten years the pavement, so far as can be seen, undergoes no change whatever.

"Modern wood block paving in the United States runs back to 1900, when the first creosoted wood pavements were laid in Massachusetts. The pavement on Tremont Street, Boston, laid in 1900, is still there and giving excellent service under the heavy traffic of that central thoroughfare There are now many miles of wood block pavement in the principal American cities, notably New York, Chicago, St. Louis, St. Paul and Philadelphia. It is widely recognized by engineers to be the highest type of pavement and has been so recognized abroad for many years. The great streets of the world, such as Champs Elysees of Paris, and The Strand and Regent Street, London, are paved with wood.

"Briefly summarized, the advantages of wood block pavement are maximum durability, no expense for maintenance, noiselessness (an important civic asset), cleanliness, perfect contour, creates no dust, reflects less heat than lithic pavements, gives easy traction.

"The commissioner of public works, on the awarding of a contract for creosoted block, appoints a responsible chemical testing bureau as the city's representative to see that the specifications adopted by the city are absolutely lived up to.

"The chemists are sent to the plant of the manufacturer as soon as the process of manufacture is started. The oils are analyzed, the lumber inspected, and an accurate record kept of the quantity of oil impregnated in each cubic foot of lumber.

"The daily record of car numbers, showing contents of cars with name of consigneee is forwarded to the commissioner of public works, together with a statement analysis of the oil and the grade of lumber.

"Material not in accordance with the specifications is rejected at the manufacturing plant."

The booklet is well illustrated with fifty photographs of Detroit Streets and about an equal number of photographs of letters from Detroit firms relating their experiences with wood block pavements.

HIGHEST AND LOWEST POINTS IN THE WORLD.

The maximum difference in elevation of land in the United States is 14,777 feet, according to the United States Geological Survey, Mount Whitney, the highest point, is 14,501 feet above sea level, and a point in Death Valley is 276 feet below sea level. These two points, which are both in California, are less than 90 miles apart. This difference is small, however, as compared with the figures for Asia. Mount Everest rises 29,002 feet above sea level, whereas the shores of the Dead Sea are 1,290 feet below sea level, a total difference in land heights of 30,292 feet. Mount Everest has never been climbed.

The greatest ocean depth yet found is 32,088 feet, at a point about 40 miles north of the island of Mindanao, in the Philippine Islands. The ocean bottom at this point is therefore more than 11½ miles below the summit of Mount Everest.

The difference in the land heights in Europe is about 15,868 feet.

COAST TO COAST.

Montreal, Que.—A strong movement has been inaugurated to induce the Federal and Provincial Governments to subsidize the construction of a highway between Montreal, Ottawa and Toronto, and to improve the highways and bridges in the interests of trade and commerce, and of better communications between these points. At a recent meeting of the city council of this city it was proposed to send a delegation to Ottawa to interview the government authorities regarding the project and to ask the government to take steps in the furthering of the scheme by voting the money necessary for roads and bridges. As the construction of this roadway would be very advantageous, the voting of the money should meet with public approbation.

Quebec, Que.—At present there is not sufficient or adequate dock accommodation on either the Atlantic or the Pacific Oceans for steamships which ply regularly to and from Canadian ports. It is authoritatively stated that the government intend to proceed immediately with the construction of modern and up-to-date docks at Halifax, Quebec and Esquimalt, capable of receiving and docking the largest steamships plying on the Atlantic or on the Pacific. The best expert advice as to the type, size and location and character of these docks will be secured. They will be available not only for merchant steamships in need of repair and examination, but also for ships of war in case of need. The advice of the Admiralty as to all matters which concern the utility of these docks for purpose of the navy in time of war will be sought.

Ottawa, Ont.—The Publicity and Industrial Bureau of the city of Ottawa, of which Mr. Herbert W. Baker is commissioner, has just sent out a most interesting map showing the water powers, minerals and transportation facilities within a radius of 60 miles of the city of Ottawa. According to the map there is shown the low-water estimate of nearly 2,300,000 horse-power within a radius of 60 miles of the city, of which 150,000 horse-power is developed. It furthermore shows that twelve steam lines radiate from Ottawa with two electric lines proposed, as are shown on the map. The water powers, as shown on the map, indicate the horse-power available and their location in respect of the city of Ottawa. Those interested in receiving a copy of this map may do so by addressing H. W. Baker, Industrial Commissioner, Ottawa, Ont. It is well worth having.

Toronto, Ont.—Word comes from Washington that a preliminary report on the recent experience in radio-telegraphy between the scout cruiser Salem, on her voyage to and from Gibraltar, and the great wireless tower at Arlington, had proved this station to be second to none in the world, not excepting Eiffel Tower or the great German wireless towers. In this first test the contract requirement of the despatch of messages from Arlington to a vessel at least 3,000 miles distant could be only realized at night, but such messages were delivered to the same by day up to a distance of 2,383 miles. It was demonstrated, too, by the use of kites on the vessels with wire conductors, messages could have been exchanged throughout the entire transatlantic trip. Results of interesting experiments made during this voyage with new forms of apparatus are said to mark a new era in long distance radio communication.

Cochrane, Ont.—It is reported that the Transcontinental Railway Commission has let the contract for the installation of a pick up water system, and that work will commence May 1. Cochrane will be the headquarters of the district for the company which has charge of the work. Engineers were here last winter to inspect the line and n[illegible] how the water could be prevented from freezing. They recommended in their report that troughs be placed every twenty miles. There will be double troughs with steam pipes running between them.

The construction of these will be a big undertaking as they will have to be laid in beds of cement and iron stays imbedded to prevent the rails from spreading. The cement work will also have to be of the best and special men are carried by the company, which installed the system on many of the big railroads in the United States.

Victoria, B.C.—The list as prepared by the Chief Forester of fires shows that 20 of the fires were caused by campers. The list is as follows:—Campers, 38; railway locomotives, 34; lightning, 23; donkey engines, 11; railway construction, 11; public road construction, 9; uncontrolled permit fires, 8; smokers, 7; accidents, 6; logging railways, 6; prospectors, 3; Indians, 3. Stringent regulations have been passed by the Board of Railway Commissioners of Canada to cover the risk of new railroads under construction in the province, the patrol has been doubled on the rights of way, and every possible precaution urged upon logging operations. The Forest Branch is endeavoring to co-operate in every way with those who have work to perform which is attended with danger to the forest. But the greatest danger of all, that of the man who is careless with his camp fire, still remains open, and it can be removed only by increased watchfulness on the part of every individual who uses the woods for pleasure or profit.

Montreal, Que.—It has been proved by evidence before coroners' juries and by the testimony of eye-witnesses that many drownings in the Lacbine Canal and along the docks would never have taken place if the victim had means within his reach to pull himself to the solid shore. Many a good swimmer who has accidentally fallen over into the water on a dark night, when no help was near, has swam about till exhausted vainly striving to secure a hold on something which would enable him to pull himself out of the water. With this knowledge in mind, Mr. Frederick J. Gilman, C.E., has invented a contrivance which, if accepted by the Dominion government, would prove helpful in life-saving, not only of persons who are so unfortunate as to fall into the water, but to help the rescuers to get them out. This invention is exceedingly simple, consisting of stringing of stout wires along the walls of the canal or harbor within easy reach of any person in the water. Above these at certain intervals are a series of other wires which would enable a person to get up on the banks.

Regina, Sask.—A first-class system of provincial highways, linking up the various parts of the province, is the latest plan of the Highway Commission, according to the statement made recently by Mr. A. J. McPherson, chairman of the commission. The idea is to provide broad and well-kept highways joining towns and villages for a hundred miles or so in different directions. For instance, one road will probably run from Swift Current to Fleming. Another will pass through Estevan, Weyburn, Regina, Moose Jaw, Saskatoon and Prince Albert—generally north and south. Still another will go from Saskatoon west to Kindersley, Kerrobert, Scott, Macklin, etc. Another will probably be from Lloydminster to Battleford. The latter, in fact, is being taken up by the municipalities themselves, and is likely to be constructed in the near future. Considerable portions of these main roads will be built by the municipalities, under the municipal roadmaking scheme. It is estimated that nearly $10 per capita will be spent by the people of Saskatchewan this year on road making. The government pro-

poses to spend about two million, and the municipalities will, it is expected, spend about three million dollars.

Ottawa, Ont.—A large deputation from Toronto, Montreal, Prescott, Cornwall, Belleville and other places seeking government assistance for the furthering of a trunk road between Montreal and Toronto which would pass through Ottawa and serve a number of other Ontario and Quebec towns and cities. The scheme, as proposed, is for a highway between Toronto and Montreal which would not only connect the two largest cities in Canada, as well as Ottawa, but would develop the rural districts along its route by bringing business to them. To gain the shortest possible route a bridge must be built across the Ottawa River connecting the Island of Montreal with the mainland in Vaudreuil county, and government assistance in its construction was requested of Hon. Robert Rogers, minister of public works. Montreal was largely represented in the delegation, among the civic authorities being Controller Godfrey and Aldermen L. A. Lapointe, Monahan and Menard. The Canadian Manufacturers' Association, the Montreal chamber of commerce, the interprovincial highway and bridge committee, the boards of trade of Cornwall, Prescott, Kingston and other towns were also included, one delegate, Col. Ponton, of Belleville, representing 63 boards of trade. Ex-Mayor Geary and Controller T. L. Church were among the Toronto representatives.

Montreal, Que.—The decision to use the space between the inner and outer shells of the Olympic for the storage of oil, to be experimentally used as fuel for one of the mighty boilers, is an interesting development in the use of oil as fuel which is so familiar a practice on certain Western railways. Nor is the use of oil for vessels any longer a novelty. One steamship company, with headquarters in the Far East, has twenty-one oil-burning ships in its service; two transatlantic lines have vessels equipped with apparatus enabling them to utilize oil. Indeed, the liquid fuel is far more generally used at sea than on land. A great advantage is that, instead of the difficult transmission of coal bags from a collier, oil can be pumped through flexible tubes into the hold of a ship to be supplied in rough weather. In such a ship as the Olympic there is an enormous saving of cargo room through the possibility of oil storage in space not otherwise utilized. The German fleet on the China station regularly uses oil; so do the ships of the Dutch navy and the Italian Admiralty. In the Far East, since Sir Marcus Samuel developed the Borneo oil fields, there are rich supplies for the constantly increasing use of liquid fuel throughout the surrounding region, supplemented by the product of the valuable oil wells in Burmah. The advantages, in brief, are the reduction in weight and space and number of men; the absence of cinders and the control of smoke; the ease with which an even temperature can be maintained; the absence of cumbersome gear for handling the coal and the ashes therefrom.

Calgary, Alta.—The department of mines was regarded by the mining engineers of Canada as an urgent necessity if the interests of the industry are to be thoroughly looked after and successfully promoted, was the statement made by Mr. E. A. Scovil, who recently attended the session of the Canadian Institute of Mining Engineers, held at Ottawa. Hitherto the mines have been under the supervision of the secretary of state, but the work has grown to such proportions that it is now imperative that a special portfolio be created in order that it may be properly attended to. The secretary of state is already loaded down with work properly appertained to his own department, and it is impossible for him to give that attention to the mining industry that it deserves. During the past few years immensely valuable mining areas have been opened up throughout Canada, more especially in Northern Ontario and in British Columbia, and the activities of the mining men of the Dominion are being rapidly extended. The experts gathered together in Ottawa, Mr. Scovil said, had considered the situation from every angle and the profitable course for Canada, they had concluded, was an establishment of a department of mines for Canada. In this opinion they were in perfect accord with mining men not members of the institute, and it was expected by all that the matter will be presented to the government so convincingly that the new department will shortly be formed.

Calgary, Alta.—The C.P.R. has opened its new shops at Ogden, near here, which are the largest railway repair shops in the world. The opening of these shops marks a new era in the annals of Calgary and district, if not the Canadian West, for where less than twelve months ago was open prairie land to-day there exists a great hive of industry. The C.P.R. has already expended several millions of dollars on the erection of buildings and equipment forming these huge and colossal works, but there still remains more to be done before the shops reach the state of perfection which is always a part of the policy of the C.P.R. The shops are of the most modern construction, and contain the latest appliances used in the construction or the repair of a locomotive that the mechanical world has devised. Eleven and a half months from the turning of the first sod for the construction of the works the C.P.R. turned out its first engine. The contract for the shops was let to the Westinghouse, Church-Kerr Company, and Mr. T. N. Gilmore, the railway equipment engineer for the contractors, supervised the work. The power plant is one of the largest in the West, containing six Babcock & Wilcox boilers, capable of developing 2,100 h.p. A concrete smoke stack, 250 ft. high, provides the draught for the boilers. The steel work itself is a revelation, no less than seven millions of pounds having been utilized in the buildings. The capacity of the locomotive shops, which will be used for the present to do heavy work on the engines, will be between six and eight hundred locomotives a year. The shops will be a great acquisition in the West, and will materially assist the company in keeping its huge rolling stock in the highest state of efficiency.

Victoria, B.C.—The government is anxious in the interest of the country, to have the timber for sale along the Grand Trunk Pacific, between Yellow Head Pass and Fort George, taken out and used before decay and insects get a firm hold. As is well known, dead timber is not able to resist either of these enemies, and it is only a matter of time before what was perfectly healthy wood is filled with a network of insects' borings and fungus growth. Damages to the extent of over $5,000,000 annually are estimated to take place in Eastern Canada and the United States. These losses may not be paralleled in the West, but there is undoubtedly vast depreciation going on at all times and this will become more and more noticeable as time goes on and timber and values increase. Logging fire-killed timber involves losses in many ways, particularly in bringing useless parts of the tree to the mill, and in the danger of breaking when the trees are being felled. There are difficulties in milling, in that the soft, punky outside layers of decayed logs take up gravel which is bad for the saw. The average results of tests of small specimens free from defects indicate that the wood of fire-killed Douglas fir, after a considerable number of years, is slightly weaker than that cut from green timber. The difference, however, is not great, and in structural sizes containing the defects ordinarily found in timber, very largely disappears. In tests which have been conducted bridge stringers of fire-killed wood proved to be somewhat less strong than the green

stringers with which they were compared; while the floor joists (of both kinds of wood) were about equal in strength. In stiffness, the fire-killed wood was fully equal to the green wood for all sizes tested. In general, tests indicate that the sound wood from fire-killed Douglas fir of the Pacific Coast may safely be used for general construction purposes, and that its merits are nearly, if not quite equal to those of material from green, growing trees. It should be emphasized, however, that these results apply only to sound wood. Pieces showing indications of decay, whether cut from green or from dead trees, should be rigidly excluded where strength or durability is important.

Victoria, B.C.—Mr. W. A. Young, the new comptroller of water rights, who is also an engineer, has been very busy lately outlining the work to be undertaken this year by the hydrographic engineers employed by the provincial government. A systematic survey of the water courses, to determine their capacity for power, irrigation and other purposes, is to be made this year in the farther outlying districts of the province. Last year the Kootenay, Okanagan, Thompson, Fraser, Nicola and Similkameen valleys were well covered; but this year these sections are to be more thoroughly examined and mapped. The government is issuing maps of the various watersheds as completed, showing the capacities of the various creeks and rivers. A feature of the policy is the assignation of different engineers to certain fixed districts, in which they will have full charge of all matters connected with hydrographic work. They are also special commissioners to investigate difficulties arising in claims for water rights, having the power to report the best policy to adopt where there is a conflict between ranchers and others.

PERSONAL.

H. L. FITZSIMMONS, of the Toronto city engineers' department, has been appointed building inspector of Prince Albert, Sask.

MR. LESLIE T. STONE, assistant engineer of the Grand Trunk Railway, at London, has been appointed division engineer.

MR. J. G. MILL is resigning from the city engineer's department, Toronto, and has been awarded the contract at Brighton, Ont., for the waterworks installation. The town will expend $50,000 on same.

MR. T. A. MURRAY, consulting engineer, Toronto, is leaving Friday, April 17th, for a month's trip to Fort William and Kenora, and as far west as Macleod, Alta., in connection with his business interests in the West.

GEO. T. CLARK'S resignation, which he recently tendered as city engineeer of Saskatoon, has been reconsidered by the council, as a result of which Mr. Clark will continue in the capacity of city engineer of that city.

MR. FREDERICK G. GOODSPEED, formerly of Penniac, York county, has been appointed acting district engineer for the federal department of public works with headquarters in St. John, N.B., succeeding Mr. J. K. Scammell, resigned.

ARTHUR H. BLANCHARD, M.Can.Soc.C.E., professor of Highway Engineering, Columbia University, on April 10th delivered an illustrated address entitled "Modern Bituminous Pavements for Municipalities" before the Board of Trade of Elizabeth, N.J.

MR. GEO. W. THOMPSON has been appointed temporary acting controller by the city council of Westmount, Que. Many applications for the position had been received from England and the United States, as well as throughout the Dominion. Mr. Thompson was previously superintendent of the light and power department of the city.

MR. CHAS. E. FRASER, B.Sc., graduate of McGill University, class of 1899, and partner of the firm of Fraser, Brace & Company, of New York, it seems, has been awarded the $3,000,000 contract for the development of the Cedar Rapids Manufacturing Co. works. Mr. Fraser's firm has also carried out successfully a considerable number of large and important contracts. Among these were the construction of a big power dam at Shelbourne, Mass., a bridge contract in the New England States, a power flume on the United States side of the Niagara Falls, and the most difficult portion of the development works of the Canadian Light and Power Company at Valleyfield, being in connection with the locks of the waterway.

F. W. THOROLD, B.A.Sc., Toronto, has incorporated the F. W. Thorold Company, Limited, consulting engineers and contractors. Mr. Thorold has had fifteen years' experience in engineering and contracting work in all parts of Canada. He was formerly chief assistant engineer for the city of Toronto, and for four years was city engineer of Calgary, Alta. He has successfully designed and superintended the construction of numerous sewerage and waterworks systems, hydro-electric developments, etc., and has conducted a large number of important surveys. The F. W. Thorold Company will specialize on municipal work and public utilities. It is the intention of the firm to make surveys, designs and reports in regard to public utilities, construct them on a contract or cost plus percentage basis and turn them over to a town or city in running order.

The following are the names of some of the engineers who have been assigned to fixed districts in regards to the hydrographic work of the British Columbia Government: Mr. W. G. E. Biker, who surveyed part of the Kootenay watersheds and determined the power which is available in the Cranbrook water district, is this year to make an exhaustive examination of the water power in and around Nelson. Mr. O. J. Bergoust, who reported on the upper Similkameen and part of the Okanagan watersheds, will this year be stationed at Revelstoke to make hydrographic observations. Mr. H. B. Hicks will continue his work in the Kootenay watershed. Mr. P. J. de Latour is already in the field with a party, with headquarters at Nicola Lake.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The headquarters of the Canadian Society of Civil Engineers were last Friday moved from 413 Dorchester Street West to 176 Mansfield Street, Montreal. Owing to this removal the regular monthly meeting scheduled for the 10th has been postponed to the 24th instant.

Announcement is made of the thirteenth annual six weeks summer school of the College of Engineering of the University of Wisconsin, which opens on the 23rd of June.

Courses of instruction and laboratory practice are offered in Electrical, Hydraulic, Steam and Gas Engineering, Mechanical Drawing, Applied Mechanics, Testing of Materials, Machine Design, Shopwork and Surveying, in addition to which subjects may be taken in the College of Letters and Science.

For bulletin address F. E. Turneaure, University of Wisconsin, Madison, Wisconsin.

THE INTERNATIONAL ROAD CONGRESS.

The city of London has issued an invitation to the members of the International Road Congress, in session June 23 to 28, 1913, to attend a conversazione, to be held in the ancient Guild Hall, to meet the mayor, aldermen, and common councillors of the city of London.

The delegates will be entertained with the traditional hospitality for which the city corporation is famous. The Guild Hall, with all its art treasures and its historic records will be open to the visitors. A dance will be given in the famous library, which will be specially arranged for the occasion. A concert will be given for those musically inclined in the council chamber.

We understand that a number of well-known Canadian road engineers and others interested in the "Good Roads" movement have intimated their intention of attending the congress.

There will necessarily be some limit to the number of those to whom invitations to these special functions can be issued, and those interested in the roads in Canada who intend to proceed to London and have not informed Mr. Rees Jeffreys, general secretary, of their intention to do so should communicate with him without delay at Queen Anne's Chambers, Broadway, Westminster, London, S.W.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, April 24, 1913 Contents of this issue on page 627

The Canadian Engineer

An Engineering Weekly

TOWER STREET ARCH BRIDGE AT FERGUS

By A. W. CONNOR*

We illustrate in this article a reinforced concrete arch bridge over the Grand River, recently completed at Fergus, Ont., for the county of Wellington. The bridge proper has a length of 100 feet and clear span of 80 feet. There is a clear roadway of 16 feet and two 4-foot 6-inch sidewalks, carried on brackets at each side. It is a bridge of the open-spandrel type, carried on two ribs, resting on which are subsidiary spandrel arches, columns, floor beams and slabs. The open spandrel arches are purely ornamental. Fig. 3 shows an elevation and Fig. 4 a cross-section which indicates how the structure is built up from the supporting ribs.

The site is well adapted for this type of structure, the abutments being on a rocky ledge on the banks of the Grand River. This ledge of rock is about 16 feet above the low-water level and about 20 feet below the road level. The rock is limestone. The concrete structure is considered to be in harmony with the scenery.

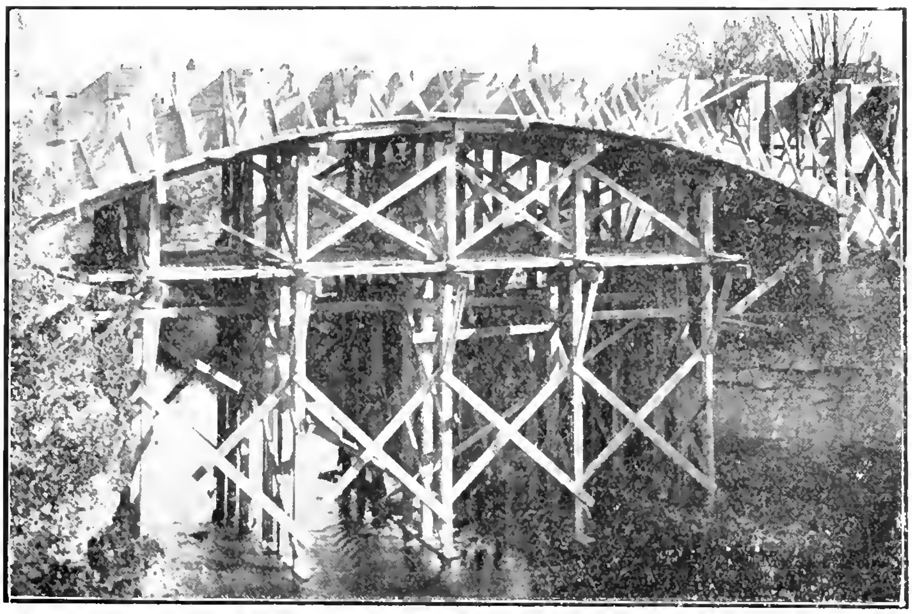


Fig. 1.—Showing Superstructure of Bridge.

The old structure was a steel deck pin-connected bridge of 75 feet span, centre to centre, resting on stone abutments, built on the same ledge. As the photograph shows, this rock has been undercut by the water. The abutments of the new bridge have been carried further back to avoid future undermining, and the arch design was favored by the engineers, as the thrust of the arch would tend to hold up the structure, even if partly undermined. The amount of the undermining was carefully determined and the faces of the abutments were set about five feet clear of the erosions. Some of the projecting portions of the rock were badly cracked, and these, together with parts necessary for getting in the foundations, were blasted off. The rock thus thrown into the stream formed a convenient means of reducing the depth of the water for setting of falseworks. The old stone east abutment, which was in poor condition, was also taken down and thrown into the river, the ends of the steel bridge being supported by a temporary wooden bent. The new west abutment was in front of the old and was carried partly below it.

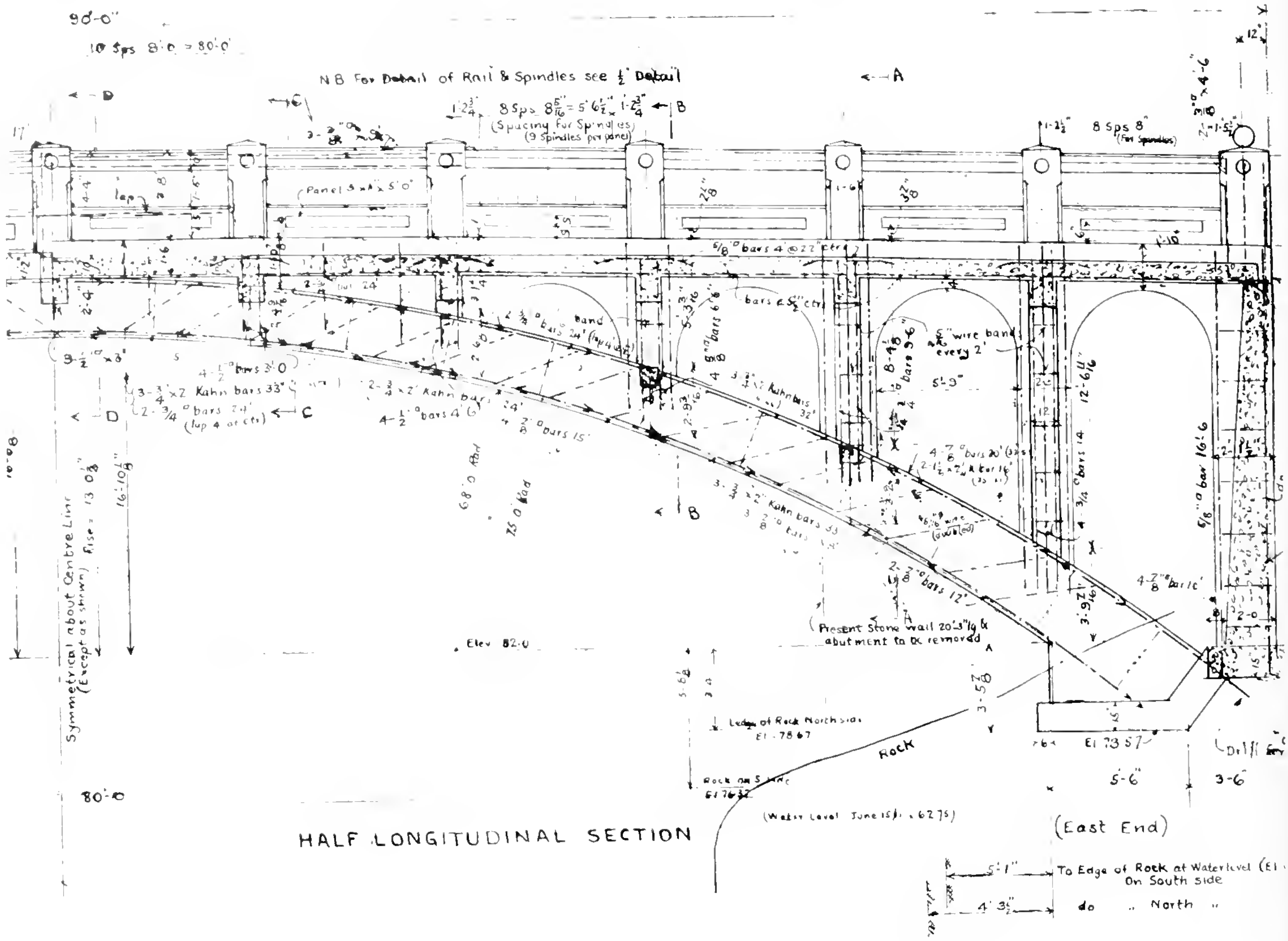
The abutments were built larger than shown on the plan, being flared out to give a larger bearing on the rock.

The falseworks were then erected in the bed of the stream. On account of the height of the work the contractor took the precaution to build a working platform under the old bridge. The old structure was then taken down with a gin pole, and short bents on top of this carried the centering.

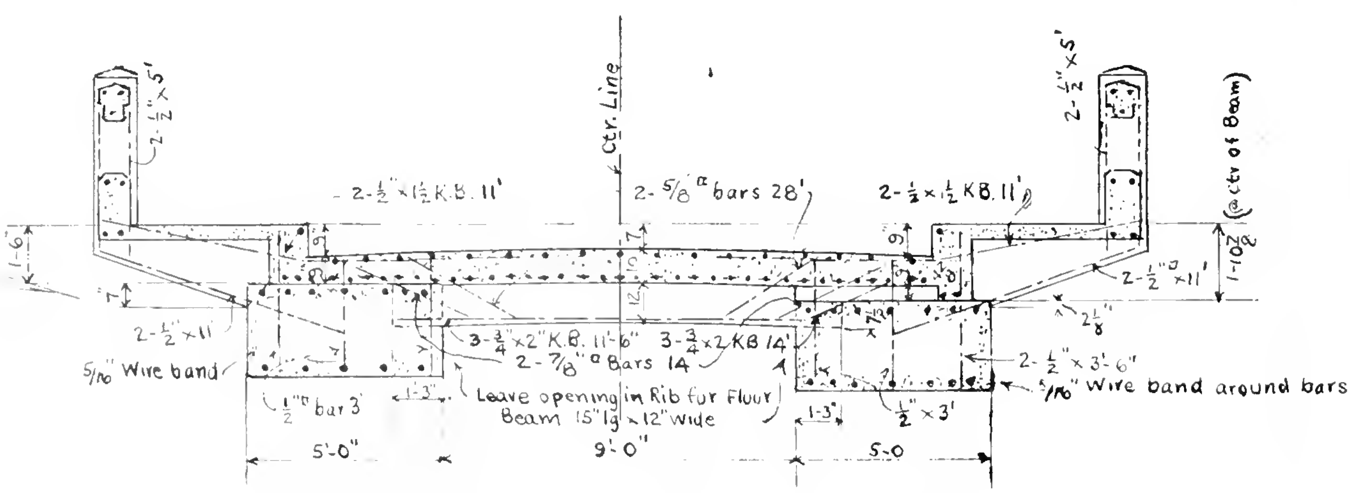
The forms for spandrels and columns were then set up. The alignment was kept by stretching two copper wires in the line of the spandrels and at the level of the crown of the roadway, which was cambered 8½ inches at the middle of the span. Care was required to get the floor beams and the circular openings in the spandrels at the proper levels. These circles were formed with sheet iron. The panel points on the ribs were finished approximately horizontal, and reinforcing rods set in to receive the columns, which were 12 inches by 48 inches wide.

All the columns were then built to the level of the floor beams. The beams and floor slab were then built together and the floor finish (a 1:2 mortar) applied as the work progressed from either end. The steel for the cantilever brackets was left projecting. There brackets were next built up to the underside of the sidewalk slab. The curb, sidewalk and

* The firm of Bowman & Connor, Consulting Engineers, Toronto and Berlin.



DESIGN FOR 80-FT. x 25-FT. CONCRETE ARCH BRIDGE OVER GRAND RIVER AT FERGUS, ONT.



Half Cross Section at "DD."

Half Cross Section at "CC."

SECTIONS OF CONCRETE ARCH BRIDGE.

NOTE.—Designed for live load of 125 lbs. per sq. ft., or 10 and 6 tons at 10-ft. centres on roadway and 100 lbs. per sq. ft. of sidewalk. All concrete 1:2:4. Where joints have to be made set forms square with surface with steel projecting through. Joints in beams and slabs to be at centre of span.

bottom part of the railing, which acts as a girder for the sidewalk slab, were then built together, and the sidewalk finished before the base had set.

The forms for the hand-rail posts and upper rail were then set up, the spindles, which were cast as the work progressed from C.I. moulds furnished by the county, were set in position and the upper rail cast around the tops of them.

Fig. 2.—View Partially Showing Under Portion of Bridge.

A ledge in the top of the lower rail was left for these spindles and this was then grouted in.

The roadway is finished as an ordinary concrete bridge floor, with a crown of 2 inches. The curb is 9 inches high, so that at some future time asphalt blocks or other paving material may be used.

Concrete cross walls were built up at both ends of the bridge. At the east end retaining walls 85 feet on one side and 135 feet long at the other side carry the roadway down to grade level. The railing on the retaining walls is a solid one with panels and posts at 16-foot centres. It is built to harmonize with the railing on the bridge, but less striking so as not to detract from the arch itself.

The bridge was designed as a parabolic arch without hinges to carry a live load of 125 pounds per square foot of the roadway and 100 pounds on the sidewalks. The roadway is also figured to carry a concentrated load of 10 and 6

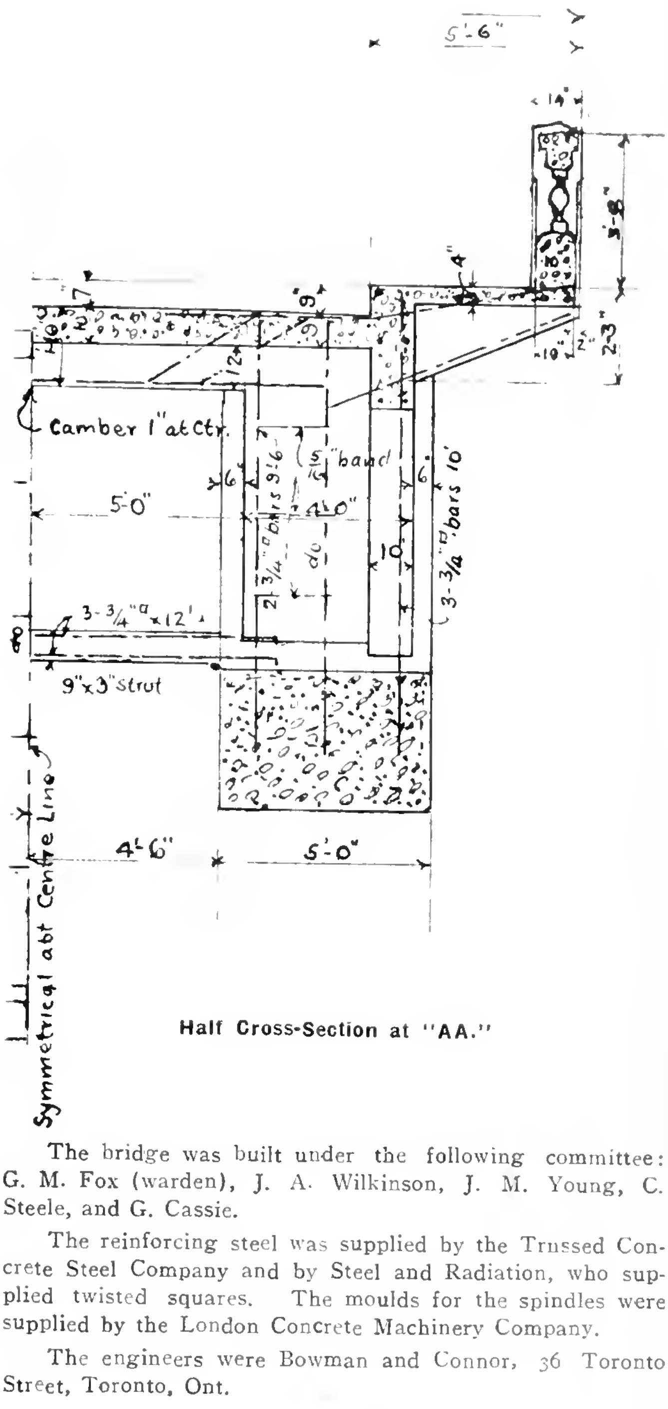
Fig. 6.—View of Bridge on Completion.

tons on two axles 10-foot centres. A temperature variation of 100 degrees Fahrenheit was also allowed for.

There are 316 cubic yards of concrete in the arch proper, with end cross walls, which are 100 feet apart. The cost of this was about $4,800. The retaining walls on the east approach contained 204 cubic yards of concrete and cost about $1,300.

All the concrete was mixed in the proportion of 1:2:4. There was no surface treatment except a wash of cement and waterproofing mixture. The finish was very good and reflects great credit on the contractor, Mr. W. M. G. Davies, of Stratford, Ont.

The bridge proper was begun in July, 1911, and finished before winter. The retaining walls were built the following spring. No crack has yet appeared in any part of the bridge



Half Cross-Section at "AA."

The bridge was built under the following committee: G. M. Fox (warden), J. A. Wilkinson, J. M. Young, C. Steele, and G. Cassie.

The reinforcing steel was supplied by the Trussed Concrete Steel Company and by Steel and Radiation, who supplied twisted squares. The moulds for the spindles were supplied by the London Concrete Machinery Company.

The engineers were Bowman and Connor, 36 Toronto Street, Toronto, Ont.

The Newfoundland government propose to extend the telegraph system around the seaboard of the island, 500 miles having been built in the past four years, with a prospect of 250 more being constructed during the present season; also to build three more wireless stations on Labrador and to establish a telephone system for St. Johns and a number of the outlying places.

ASTRONOMICAL STUDY OF THE UNIVERSE.

At the annual meeting for 1913 of the Royal Astronomical Society of Canada the president, Mr. L. B. Stewart, professor of Astronomy at the University of Toronto, in his presidential address, spoke on "The Structure of the Universe." That portion of his address which we believe will be of most interest to our general readers we abstract and publish as follows:—

It is proposed to sketch briefly the methods of investigation used in the study of the universe, the principal facts that have been learned up to the present, and some probable conclusions that may be drawn from those facts.

If it were possible to measure the distances of the stars with the ease and precision of determinations of direction, the investigation of the form of the stellar universe, and the distribution and motions of its individual members, would be a simple question of time and labor; but unfortunately astronomers are met at the outset by the impossibility of determining by direct methods, the distances of any but a few hundreds of the millions of stars that can be seen in our telescopes.

The only direct method of determining the distance of an individual star is by observing the difference in its direction as seen from the earth when at opposite points of its orbit. This is double the star's annual parallax. The relative method, by which these determinations are usually made, is admittedly unsatisfactory, especially in the case of small parallaxes, as it gives only the difference between the parallax of the star under investigation and the mean of those of the comparison stars, so that the result is always too small, and is frequently negative, showing that the parallax star is farther away than the mean distance of the comparison stars.

Another method—of limited application, as it can only be applied to binaries—has been recently used with success to determine the parallax of such systems. Micrometer measurements give the angular dimensions of the relative orbit of a pair of stars that are physically connected; but it was shown by Fox Talbot in 1871 that if in addition the radial velocities of the individual stars are found by means of the spectroscope, the absolute dimensions of the orbit of each star about the centre of gravity of the system, the masses of the individual stars, and finally their parallax, could be computed. In order that the method may be applicable it is necessary that the stars be separable in the field of the telescope. Burnham has separated stars closer to one another than 0".25, and it is considered possible to separate stars as close to one another as 0".1. In the cases of very distant binaries, if separable, they are situated at such wide distances apart that their relative motion is so slow that centuries must elapse before their orbits can be determined.

A method depending upon a study of the proper motions of the stars of a group, which may be used to obtain the mean parallax of the group, may be thus briefly described: The observed proper motion of a star is compounded of a real motion of the star in space projected upon the celestial sphere, and an apparent motion, termed the parallactic motion, resulting from that of thee solar system. This observed proper motion may be resolved into two others, one perpendicular to the direction of the sun's way, the other parallel to it. The former is termed the τ component and is independent of the solar motion, and the latter the apical component. This latter is composed of the resolved part of the true proper motion of the star, and the parallactic motion.

Having outlined thus briefly the principal methods of investigation that are applied to the stellar universe, let us turn next to some of the results of the investigations that have been made, and the conclusions reached by their discussion.

Before doing so, however, it will be well to place before us some of the questions to which answers are sought, in prosecuting the study of our stellar system. The following are some of these questions:

Is the universe infinite in extent? If finite, are there other systems separated from ours by immeasurable distances; or do all the stars, nebulæ and clusters, that are visible in our telescopes, or on our photographic plates, form a single system; or are the nebulæ, or some of them, separate systems situated at such vast distances from us as to be irresolvable? Have our telescopes penetrated to the confines of the stellar universe, so that the stars that are brought to light by increased power, or longer exposure, are merely fainter stars and not more distant ones?

As before stated, a full answer to these questions cannot be given at present, and possibly a complete solution of the problem will never be reached, though probably the main conclusions arrived at by a discussion of the facts now in our possession will only be modified by future discoveries.

That the universe is finite in extent has long been considered as proved, from the fact that, if infinite, the heavens would shine everywhere with a brightness equal, at least, to that of our sun. This conclusion is only valid if there is no absorption of light in its passage through space; and experimental evidence seems to be accumulating which points to a possibility that there is such absorption, though the evidence cannot be considered entirely convincing.

Prof. Newcomb's conclusions regarding the extent of the universe may be thus summarized: The universe is limited in extent, and probably extends farther in the plane of the Milky Way than in the direction of its poles, but in every direction much farther than the limit within which the proper motions of stars have yet been determined. The boundary is probably somewhat irregular, and the stars gradually thin out as it is approached. It is quite possible that far outside our universe there may be collections of stars of which we know nothing. It is not possible to decide whether the star masses of the Milky Way lie on the boundaries of the universe or not; the number of lucid stars that seem to lie within the Milky Way favor the view that that body is contained within the stellar universe. The stars lying without the galactic region show no tendency to collect in clusters, but are distributed throughout space with some approach to uniformity.

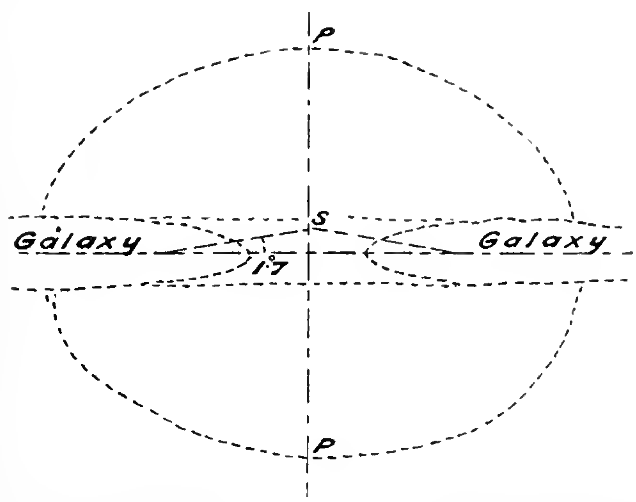
Several estimates of the distance of the Milky Way have been made, based upon different principles and assumptions, and which therefore differ widely in their numerical amounts. Professor Very makes an estimate of its distance by means of the parallax of Nova Persei. Bergstrand had found that quantity to be 0".03, but from considerations based upon the rate of expansion of the nebulosity seen to surround the star after the outburst, Professor Very concluded that his value was too small, and placed it at 0".05. This makes the distance about 60 light years. He assumed the nova to be situated within the condensed part of the spiral structure of the galaxy; and it may be remarked here that nearly all the novæ recorded during the last 300 years are situated in or very near the galaxy, and so appear to be in some way connected with it.

He then proceeds to estimate the distance of the Andromeda nebula in a similar way. A nova appeared in the centre of the nebula in 1885, and attained the 7th magnitude. By assuming its intrinsic brightness to be equal to that of a galactic star of zero magnitude, its distance is found to be

1,579, or approximately 1,600 light years. He finally expresses the opinion that the smallest and faintest of the white nebulæ may be galaxies at a distance of 1,000,000 light years, thus advocating the theory advanced by Herschel, that our stellar system is quite limited in extent, and of the form of a spiral nebula, and that the spiral nebulæ are similar systems separated from ours by vast distances.

Some have found a difficulty in reconciling the above moderate estimate of the distance of the Milky Way with the accepted fact that the stars having sensible proper motions are probably much nearer than the Milky Way, and have smaller parallaxes than that corresponding to the above estimated distance. It may also be observed that as the spiral nebulæ congregated in the neighborhood of the galactic poles, they are probably part of our stellar system; certainly that fact does not strengthen the view that these nebulæ are separate systems.

It occurred to me recently that an estimate of the distance of the galaxy may be made by a purely geometrical process, which is here given for what it is worth. It has been shown that the galaxy is not quite a great circle of the celestial sphere, but lies in about 1°.7 south galactic latitude, showing that the solar system is a little to the north of the galactic plane. This conclusion is strengthened by the ob-



P.P.—Poles of Milky Way. S.—Position of Solar System.

Hypothetical Form of the Universe. Section Through the Poles of the Galaxy.

served greater star density in the direction of the south pole than in that of the north pole, Seeliger having found the densities to be 3.14 and 2.78 respectively, per square degree. If it be assumed that this difference of density is due solely to differenc of distance, the distances of the poles of the galaxy will then be to one another in the ratio of the cube roots of the above star densities, or .96. Then if the additional assumption is made that the galactic plane divides the stellar universe equally, it is found that the distance of the solar system to the north of the galactic plane is .01 of the polar diameter of the universe. The angle subtended by this distance at the centre of the galactic region being 1°.7, the distance of the galaxy in terms of the polar diameter is found to be .342. If we then assume with Newcomb that the polar diameter of the universe is about 6,000 light years, the distance of the galaxy is 2,052 light years.

Taking this as the distance to the central region of the galaxy, and assuming, as shown by Professor Campbell's investigation, that its nearest part is distant about 500 light years, the farthest portions will then be about 4,600 light years from the sun.

This estimate fits in well with the distance to the limits of the universe in the region just outside the Milky Way, found from its star density, and Newcomb's conclusion that the Milky Way lies partly within the space occupied by the non-galactic stars.

In a brief survey of such an extensive field it is impossible to cover the ground completely, so I have merely attempted to give a general view of that portion of it marked off for examination at the outset. Astronomers realize that problems of the universe cannot be solved in a generation; that results can only be achieved by the co-operation of the present generation with those to come; each contributing its few grains of truth, which will finally be arranged in order. The astrographic chart of the heavens, now nearing completion, is the noblest legacy which the present generation as astronomers can bequeath to future generations. In their hands, by a repetition of the work, it should be the means of giving an insight into some of the problems of nature, about which at present we can only conjecture.

This principle of co-operation, though general in science, specially exemplified in astronomy, as its history shows. Tycho Brahe, though adopting erroneous views of the solar system, provided Kepler with the accurate positions of the planets that enabled him to formulate the laws which bear his name. These, in their turn, laid the foundation of a mechanical theory of the solar system, which, as developed by Newton and his successors, has made astronomy what it is to-day, giving us an almost perfect knowledge of the motions of the bodies of the solar system. Again, the foundation of stellar astronomy may justly be said to have been laid by Bradley, who made the first accurate observations of the positions of the stars. His catalogue, re-computed by Dr. Auwers in 1882, is the basis of our knowledge of proper motions, upon which many of the modern theories of the universe are built. Astronomers of to-day are doing their share in handing down to posterity the great star map. They, in their turn may, a century hence, find it necessary to repeat the work, extending it to include stars of the smallest observable magnitude, in order to advance knowledge of the stellar universe another step towards the final goal; which probably can only be approached asymptotically, by successive approximations, each vantage point being reached by a continually increasing amount of labor.

FORT WILLIAM'S PUBLIC UTILITIES.

The annual report of the manager of Fort William's utilities for the year ended December 31st, 1912, shows that there has been a net gain of $4,025.04 in the telephone department during the year as compared with a deficit from the operation of this utility during the year of 1911 of $2,728.30

The increase in the surplus of the light department is $21,085.19, as compared with a gain of $13,309.28 during the year 1911.

The revenue and expenditure in the three utilities, light, water and telephone, are as follows:—

Water Operation.—Total revenue, $75,091.74; operation, debenture interest and sinking fund, $88,015.14; deficit, $12,923.40.

Light Operation.—Total revenue, $99,310.97; operation, debenture interest and sinking fund, $78,225.79; profit, $21,085.18.

Telephone Operation.—Total revenue, $44,684.73; operation, debenture interest and sinking fund, $40,659.69; profit, $4,025.05.

HISTORY OF THE MAIN DRAINAGE SCHEME OF LONDON, ENGLAND.

The works which have been in progress for some years past with the object of improving the London main-drainage system are now approaching completion, and, although certain additional works are to be carried out, the great schemes authorized by the London County Council in 1899 and 1903 are now in practical operation The capital expenditure on the main-drainage works of the metropolis was £6,824,877 up to March 31st, 1912, making a total expenditure of $59,264.560.

It was not until the year 1856 that steps were taken to provide for the complete interception of the sewage of the metropolis and for its discharge into the river below London instead of within the boundaries of the City. The scheme then adopted on the advice of Sir Joseph Bazalgette, the chief engineer to the Metropolitan Board of Works, required eighteen years for its completion, and consisted in the construction of intercepting sewers parallel to the course of the River Thames and connected to the old main sewers. The sewers on the north side of the river terminated at Barking, eleven miles below London Bridge, and the south side sewers at Crossness, thirteen miles below London Bridge. Three such sewers, high, middle, and low-level, were provided on the north side of the river. The high-level and middle sewers converged at Old Ford and the low-level sewer at Abbey Mills, Stratford, all three being carried side by side thence to Barking on an embankment known as the northern outfall. Four main sewers were also provided on the south side of the river, converging at Deptford, and carried as one sewer, known as the southern outfall, to Crossness. The northern high-level and middle-level sewers and two of the sewers on the south side of the river drained either to Barking or to Crossness by gravitation, but pumping plant had to be provided in the case of the low-level sewers at Pimlico, Stratford, and Deptford, and these pumping stations, to which additions have been made at different periods, are still employed in the drainage scheme of the London County Council.

The completion of the Bazalgette scheme added to the old main sewers, which had been constructed at right angles to the river, a comprehensive system of parallel and outfall sewers which were of sufficient capacity to meet the needs of that period. The population of London at that time, taking the mean of the official figures in the Census of 1851 and 1861, was 2,586,000, but the plans adopted were designed for a population of 3,450,000. The dry weather flow provided for was 108 million gallons a day and 286 million gallons of rainfall, but the discharging capacity of the sewers was made much larger than this quantity in view of the fluctuations in the rate of flow. The old sewers, which discharged directly into the Thames, were utilized as storm overflows, and their employment for this purpose had the effect of relieving the floodings which had previously taken place in times of heavy rainfall.

At the outset the sewage was discharged into the river from both the northern and the southern outfalls without any artificial treatment whatever, and, indeed, it was not until the year 1891 that the precipitation works at Crossness were completed, the works at Barking having been finished two years before. The chemical treatment of London sewage is, however, still in the experimental stage, and, of course, the question is not so urgent in the case of the metropolis, where the discharge is into a large river with great tidal capacity, as in that of inland towns discharging into small streams. To safeguard the future, however, the London County Council have acquired an additional area of 750 acres at the outfalls in anticipation of the further treatment of London sewage by bacterial or other methods. Sir Maurice Fitzmaurice, the late chief engineer to the Council, in a report made shortly before his retirement, expressed the opinion that the further purification of London sewage will not be necessary for some years, but that meanwhile experience in sewage purification elsewhere should be carefully watched.

The Metropolitan Board of Works was superseded by the London County Council in 1889, and, though the need for fresh works had been recognized, it was not until ten years later that the plans for the extension of the drainage works now completed were definitely formulated. The need for additional sewers arose not from any defects in the old scheme, but from the operation of perfectly natural causes. The population of two and a half millions on which the original drainage plans were based was mainly on the north bank of the Thames, the population of the south side at that time being only 691,761. The rapid inrease of the population during recent years, particularly on the south side of the Thames, and the substitution of houses and streets for fields and arable land, not only increased the volume of sewage, but swelled the amount of rain flowing into the sewers. Relief works, therefore, became necessary, and the construction of the additional sewers and works was put in hand in 1901, no fewer than twenty-four main contracts, exclusive of contracts for machinery, having been placed for this work.

The additional sewers which have been provided on the north side of the Thames bring the total of additional sewers, other than storm relief sewers, constructed on the north side of the river up to a length of about forty-four miles.

The additional drainage works on the south bank of the Thames bring the aggregate up to about thirty-three miles of new southern sewers.

The Method of Construction.—The construction of the new sewers has presented greater difficulties than those which had to be met in the carrying out of the original scheme. The area covered by buildings is now much larger, and the number of pipes laid underground and the existence of a large mileage of tube railways made the selection of the routes of the sewers a subject needing careful consideration. On the north side of the river a good deal of the excavation was in the London clay. On some sections the Greathead shield method of driving was adopted, and in places where water-bearing ballast was encountered, as in the case of the length of new low-level sewer westward from Trafalgar Square, it was necessary to work under air pressure. This sewer is carried under the Metropolitan District, and East London Railways, and over the newer "tube" lines. Different strata were met with on the south side of the river. The new southern high-level sewer is mainly in chalk and ballast. The new low-level sewer from Battersea to Deptford lies for a portion of its length in waterlogged sands and gravels, and here also it was necessary to work under pressure, and to employ, as for certain sections on the north side of the river, bolted iron ring construction. On these lengths liquid grouting applied under pressure was used to form a solid backing, and the ironwork was lined with 3 to 1 concrete and the invert faced with blue bricks.

In addition to the new lengths of sewers, about ten miles of storm relief sewers have been constructed. It is now proposed to carry out extensive works for the relief of Holloway, and North London generally, and also of the area in the valleys of the rivers Wandle and Graveney and other parts of South London. The total length of main intercepting and storm sewers taken over from the Metropolitan Board of Works was about 283 miles, and the length of the County Council additions, which are principally large main sewers, is about eighty-seven miles. The length of local sewers

draining into the main system is not accurately known, but there is generally a sewer in every street, and the total length of the streets is about 2,200 miles.

Pumping Stations.—The total discharging capacity of the outfalls and storm water pumping stations is 2,171,000,000 gallons in twenty-four hours. Considerable additions have recently been made to the pumping station plant at Abbey Mills and at Crossness, and additional storm water pumping stations have been erected at Chelsea on the north side of the river, and at Battersea and Shad Thames on the south side. A new engine-house is also being provided at Crossness. Of the eleven pumping stations now in operation the five principal ones, in which the motive power is steam, are continually employed in lifting sewage, although at three of them the plant can also be used to pump storm water direct into the river. The total indicated horse-power of these five steam plants is between 5,000 and 6,000, and the gross capacity 460,000 gallons a minute. The dead lift ranges from 19 ft. to 41 ft. The duty of the other six stations, where gas-driven plant has been installed, is to pump storm water into the river at times of excessive rain. The total indicated horse-power of the plant is between 8,000 and 9,000, and the capacity 300,000 gallons a minute. The average dead lift is between 12 ft. and 20 ft. In addition, large quantities can be discharged by the storm relief sewers, which act by gravitation, though the amount cannot be accurately estimated.

The first proposals for the new works were made in 1891 by the late Sir Benjamin Baker and Sir Alexander Binnie, the latter then chief engineer to the Council. The final scheme was laid before the Council by Sir Alexander Binnie in 1899, and was then approved. The greater part of the works, with additions and modifications, and also the scheme for flood relief works, were designed and carried out under the superintendence of Sir Maurice Fitzmaurice, late chief engineer, and are being completed by his successor, Mr. G. W. Humphreys. Mr. J. E. Worth, the district engineer, has had general charge of the works on the north side of the river, and Mr. R. M. Gloyne has acted in a similar capacity on the south side. Mr. H. M. Rounthwaite has been responsible for the mechanical work.

ELECTRIC PROPULSION FOR CANADIAN SHIP.

The electrical system of ship propulsion advocated by Mr. Henry N. Mavor, of Glasgow, will be tried for the first time in a merchant vessel in the oil-engined ship Tynemouth, launched at Middlesbrough, England, last week. The only vessels of this type so far are the small experimental craft Electric Arc, with which Mr. Mavor carried out trials of his transmission gear on the Clyde, and a collier for the United States navy. The Tynemouth, which is 250 ft. long and of 2,400 tons deadweight on fresh water, has been built for the Montreal Transportation Company, and is intended for cargo service on the Canadian Lakes.

For propelling purposes she will have two Diesel engines, each developing 300 b.h.p., and between them and the propeller there will be interposed Mr. Mavor's electrical gear, which is being manufactured at the works of his firm in Glasgow. This gear is designed to allow the Diesel engines to run at a constant high speed generating electricity, and at the same time to permit the use of a slow-moving propeller of coarse pitch, reversing, stopping, and starting being carried out independently of the prime mover. For efficient service on the Canadian lakes a large propeller running at not more than 800 r.p.m. is wanted, and so far it has been found possible to meet this requirement only with reciprocating steam engines.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS.

By A. F. Ganz.

(Continued from page 588 of last issue.)

While relief from serious electrolysis can at times be obtained by such special measures as insulating pipe coverings or insulating joints, it must be understood that all remedial measures should have for their first aim the reduction of the drop in potential in the rails to a minimum, because this removes the cause of the trouble. The first and most important step necessary to accomplish this is to maintain the rails perfectly bonded, so that the rails themselves form continuous electrical conductors. The next important step is to limit the radius from the power station to which

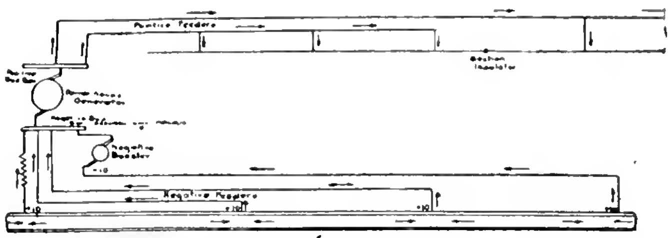


Fig. 17.—Single-Trolley Railway with Insulated Return Feeders and Negative Booster, Showing Path of Currents and Assumed Rail Potentials.

the station supplies electric power, so that current does not have to be returned from excessive lengths of rail lines to any one power station. This is usually accomplished in practice by supplying power to electric railways from distributed substations. The next step is to remove the current from the rails wherever there is concentration of current by means of insulated return feeders connecting from the rails at these points to the power station. In order that such insulated return feeders should be most efficient in reducing drop in potential in grounded rails these feeders should be proportioned for equal drop, so that the rails at all points where

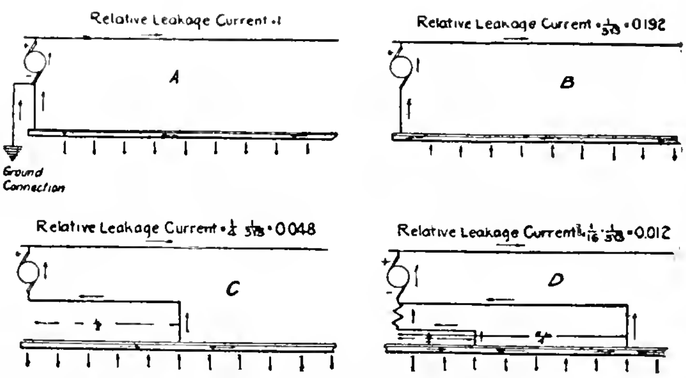


Fig. 18.—Relative Leakage Currents with Various Return Circuit Conditions.

return feeders are connected are maintained at substantially the same potential under average load conditions. This also requires that the rails immediately in front of the power station must not be connected directly to the negative bus-bar, unless a resistance corresponding to the average resistance of the return feeders is connected in this circuit. Where it is necessary to bring current back from a distant point in the rails it is sometimes more economical to employ a negative booster in series with this return feeder rather than make this feeder of such large cross-section as would be re-

quired to maintain the distant point in the rails at the same potential as the nearer connection points. With this system part of the voltage drop is actually removed from the rails and transferred to the insulated return feeders from which current cannot leak to ground.

An illustration of such an insulated return feeder system, proportioned for equal drop, is shown in Fig. 17. In this illustration it is assumed that the negative bus-bar is at zero potential and that the return feeder connection points on the rails are maintained at a potential of 10 volts with reference to the negative bus-bar. Under these circumstances there is no tendency for current to flow from the rails between points where feeders are connected to the rails. The drop of 10 volts in the return feeders has also been removed from the rails.

The possibilities in the way of reducing stray currents by means of properly proportioned insulated return feeders was clearly shown by Mr. George I. Rhodes, in a paper entitled "Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders," published in the Transactions of the American Institute of Electrical Engineers for 1907. A few of the figures from Mr. Rhodes' paper are reproduced in Fig. 18, with diagrams illustrating the application of these figures. It will be seen that, with the negative bus-bar grounded through a ground connection of negligible resistance, in addition to being connected to the rails at the power station, the greatest amount of stray current is produced, which is assumed unity for purpose of comparison. This is illustrated by Diagram A, Fig. 18. Disconnecting the negative bus-bar from ground connections at the station, but not from rails, reduces stray currents to one-fifth their former value, as illustrated by Diagram B of Fig. 18. Disconnecting the negative bus-bar from ground connections and from the rails at the power station, and returning the current by means of one insulated return feeder from the centre of the line, reduces stray currents to 5 per cent. of their former value, as illustrated by Diagram C of Fig. 18. By using two insulated return feeders with the negative bus-bar insulated, the stray currents are reduced to 1.2 per cent. of their former value, as illustrated by Diagram D of Fig. 18. It, therefore, can be seen that very great reduction of stray currents can be accomplished by insulating the negative bus-bar at the power station from ground connections and from rails, and returning the current by means of insulated return feeders.

Since power stations are usually located near the centre of load of an electric railway system, it is usual in cities to find railway lines radiating out from the power station. Where the running tracks are connected to the negative bus-bar only in the immediate neighborhood of the power station, these running tracks are depended upon alone to return current to the power station, and there is consequently always very great concentration of stray current under these circumstances in the neighborhood of the power station. Such railway lines radiating out from the power station are illustrated diagrammatically in Fig. 19. In this figure eight railway lines are assumed radiating out from the power station. In the left-hand diagram of Fig. 19 the rails of these lines are shown connected to the negative bus-bar at the power station only. It is seen that, as the result of this, all of the current used on the eight railway lines flows in the rails towards the power station. The stray currents which leak from the rails to ground also concentrate in ground and on the underground piping in the neighborhood of the railway power station, where they must return to the rails to get back to the negative bus-bar.

If this connection between the negative bus-bar and the rails at the power station were removed, and the currents returned from the rails at points near the centre of each railway line by means of insulated return feeders, as shown in the right-hand diagram of Fig. 19, this concentration of current in the neighborhood of the power station would be entirely removed. With this arrangement, the current used by each individual line would tend to flow away from the rails at points away from the centre of each line, and towards the rails near the centre of each line. It is, therefore, seen that there is only ⅓ of the current returning from the rails at any one point than there is when the rails are connected to the negative bus-bar only at the power station. Further, the total stray current through ground with the conditions shown in the right-hand diagram will be only ¼ of the total

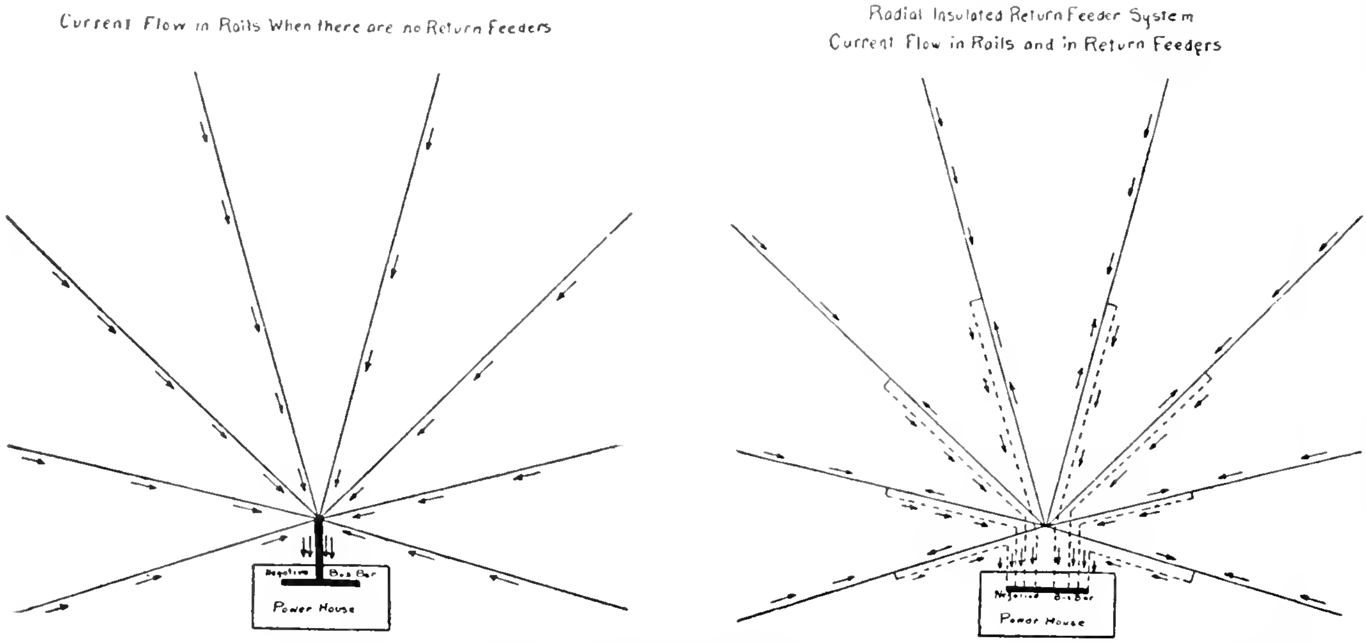


Fig. 19.—Showing Trolley Lines Radiating from Power Station With or Without Insulating Return Feeders and Showing Path of Return Currents.

stray current with the conditions of the left-hand diagram, assuming similar soil conditions, so that at any one point the danger from electrolysis will be 1/32 of what it is in the neighborhood of the power station with the first arrangement. As a matter of practice, however, the actual reduction is very much greater, because the return feeder connection points on the rails can be chosen so as to be located where the ground is high and dry, and consequently of high resistance, while the railway power station is generally located near water, where the ground is wet and of low resistance. Instead of connecting one insulated return feeder to the middle point of every line, as indicated in Fig. 19, a number of such feeders may be connected to a number of properly selected points in every line. In this way the drop in the rails, and consequently also the stray current produced, can be reduced to any desired value. In many cases the benefit to be derived at comparatively small cost from insulated return feeders with negative bus-bar insulated is much greater than above indicated. This is particularly true when the power house is at one side of a main network of tracks and connected to it only by a single branch line. To connect the negative bus-bar to the tracks of this single branch at the power house means concentrating the major part of the track drop within a short distance of the power station. In such case, the insulation of the negative bus-bar, and the use of insulated return feeders to the central rail network, will at once take the greater part of the drop out of contact with ground. This will eliminate the greater part of the cause of the trouble, as well as enormously reduce the concentration of the remaining stray current in the positive district. Thus the advantage gained by insulating the negative bus-bar is often very much greater than that indicated for the typical case above described.

The reduction of drop in potential in rails, for the purpose of minimizing electrolysis, is the basis for various regulations and ordinances which have been enacted for the purpose of protecting underground metallic structures from electrolysis. For example, the well-known English Board of Trade Regulations limit the maximum allowable potential difference between any two points in the rails to 7 volts. In Germany, a joint committee, representing the electric railway, gas and water interests, has adopted a regulation limiting the average allowable potential difference between any two points in the rails to 2.5 volts within a district encircling the urban district by a radial distance of 2 kilometers. Beyond this circle, the average potential drop in the rails must not exceed 1 volt per kilometer.

Where railway return circuit improvements have been made, to such an extent that there are no longer any excessive drops in the grounded rails, it is generally found that stray currents on underground pipes are reduced to small and often negligible amounts. Where, however, stray currents which are considered too large for safety are still found on such underground pipes after the railway return circuit has been thoroughly improved, then it is frequently possible and feasible to apply one or more of the other remedial measures, such as insulating joints in the pipes to take care of the small remaining stray current. Such other remedial measures, as bonding or insulating joints in pipes must, however, never be applied unless the railway return circuit has been improved sufficiently to eliminate all excessive drops in the grounded rails.

Summary and Conclusions.—Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bonding, to ground connections from the negative bus-bar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact, which is not generally appreciated, that where large stray currents exist, due to the above causes, these can always be reduced to a small fraction of their present value by removing all ground connections of the negative bus-bar and installing insulated return feeders proportioned for equal drop from radially disposed points in the track system located at some distance from the power station. By this method the rails are drained of current, and any desired part of the voltage drop can be removed from the rails and transferred to insulated conductors from which currents cannot leak. In Europe such radial insulated return feeders, for bringing current back from the rails to the power station, are made necessary by regulations limiting the allowable drop in voltage in the rails; and, in most cases, such installations of insulated return feeders have substantially removed serious trouble from electrolysis. This system of minimizing stray currents by means of radially disposed insulated return feeders has also been installed in a number of American cities, and the method is becoming recognized by railway engineers as by far the best for minimizing stray currents. This system, in fact, removes the root of the trouble, by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is, therefore, correct in principle. The railroad companies frequently object to this system, claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities to-day. The fact is that in many electric railways there is practically no installation of negative feeders, and that the railway companies are often not willing to install even a moderate amount of return feeder copper. A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Where the negative bus-bar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is only reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This, however, is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current, can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit. In order to effectively install and maintain an adequate return feeder system that will reduce stray currents on underground piping systems to reasonably small values, it is essential that the pipe-owning companies should co-operate with the railway companies by affording them access to their pipes for making necessary measurements, etc. After a railway company has installed a reasonable and fair return circuit, it sometimes also happens that it is desirable to eliminate any remaining current on pipes by the use of properly located insulating joints. Under these circumstances the pipe-owning companies should be willing to co-operate with the railway company in the installation of such joints.

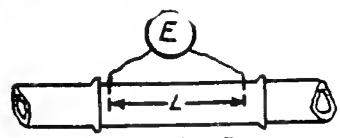
It is the author's firm conviction that such remedial measures as pipe drainage or insulating pipe joints should be used (if at all) only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures.

Table for Determining Current Flow on Iron Pipes from Millivolt Drop Along Continuous Length of Pipe.
Computed by Albert F. Ganz, M.E.

L = Distance between contacts, feet.
E = Instrument reading, millivolts.
K = Constant from table.

Current flow, amperes = $\frac{KE}{L}$

Wires must not span joint.



Cast Iron Water Pipe.

American Water Works Association Standard—Adopted 1908. Weight 1 cubic foot = 450 pounds Resistance 1 pound foot = 0.00144 ohm.

Design.	Nominal Diam. of Pipe.	Weight per Foot Exclusive of Bell	Resistance per Foot Exclusive of Bell.	K Current for 1 Millivolt Drop per Foot of Continuous Pipe.
	ins.	*lbs.*	*ohm.*	*amps.*
100 feet head, 43 pounds pressure.	4	18.1	0.0000795	12.6
	6	27.9	0.0000516	19.4
	8	38.8	0.0000371	27.0
	10	52.1	0.0000276	36.2
	12	67.1	0.0000215	46.6
	14	82.5	0.0000175	57.3
	16	99.0	0.0000146	68.7
	18	118.	0.0000122	82.0
	20	138.	0.0000104	95.8
	24	187.	0.0000077	130.
	30	267.	0.00000539	185.
	36	359.	0.00000402	249.
	42	465.	0.00000310	323.
	48	609.	0.00000236	423.
	54	733.	0.00000196	509.
	60	838.	0.00000172	583.
	72	1170.	0.00000123	813.
	84	1450.	0.000000994	1010.
200 feet head, 86 pounds pressure.	4	20.1	0.0000716	14.0
	6	31.2	0.0000462	21.6
	8	42.7	0.0000337	29.7
	10	59.0	0.0000244	41.0
	12	76.6	0.0000188	53.3
	14	95.0	0.0000152	66.0
	16	115.	0.0000125	79.9
	18	138.	0.0000104	95.9
	20	163.	0.00000884	113.
	24	218.	0.00000661	151.
	30	313.	0.00000460	217.
	36	419.	0.00000344	291.
	42	544.	0.00000265	379.
	48	689.	0.00000209	479.
	54	847.	0.00000170	588.
	60	1010.	0.00000143	702.
	72	1420.	0.00000101	986.
	84	1880.	0.000000767	1310.
300 feet head, 130 pounds pressure.	4	21.3	0.0000676	14.8
	6	33.0	0.0000436	22.9
	8	48.1	0.0000300	33.4
	10	65.6	0.0000219	45.5
	12	85.6	0.0000168	59.5
	14	108.	0.0000133	75.0
	16	134.	0.0000107	93.1
	18	163.	0.00000884	113.
	20	191.	0.00000754	133.
	24	258.	0.00000558	179.
	30	368.	0.00000392	256.
	36	498.	0.00000239	346.
	42	659.	0.00000218	458.
	48	834.	0.00000173	579.
	54	1040.	0.00000138	723.
	60	1220.	0.00000118	847.
	72	1750.	0.000000823	1220.
400 feet head, 173 lbs. pressure.	4	22.8	0.0000631	15.8
	6	35.4	0.0000407	24.6
	8	51.2	0.0000282	35.6
	10	71.6	0.0000202	49.7
	12	93.9	0.0000153	65.2
	14	119.	0.0000121	82.6
	16	148.	0.00000973	103.
	18	179.	0.00000805	124.
	20	213.	0.00000676	148.
	24	286.	0.00000503	199.
	30	422.	0.00000342	293.
	36	583.	0.00000247	405.
	42	765.	0.00000188	532.
	48	962.	0.00000150	668.
	54	1230.	0.00000117	854.
	60	1460.	0.000000987	1014.
500 feet head, 217 lbs. pressure.	6	37.8	0.0000381	26.2
	8	56.7	0.0000254	39.4
	10	78.9	0.0000182	54.7
	12	104.	0.0000138	72.2
	14	133.	0.0000108	92.4
	16	165.	0.00000873	115.
	18	203.	0.00000710	141.
	20	241.	0.00000598	167.
	24	329.	0.00000438	228.
	30	481.	0.00000300	334.
	36	668.	0.00000216	464.
600 feet head, 260 lbs. pressure.	6	39.6	0.0000364	27.5
	8	60.7	0.0000237	42.2
	10	84.7	0.0000170	58.9
	12	113.	0.0000127	78.5
	14	146.	0.00000987	101.
	16	181.	0.00000795	126.
	18	220.	0.00000654	153.
	20	266.	0.00000541	185.
	24	362.	0.00000398	251.
	30	539.	0.00000267	375.
	36	754.	0.00000191	523.

Table for Determining Current Flow on Piping from Millivolt Drop Along Continuous Length of Pipe.—Continued.

Cast Iron Gas Pipe.
American Gas Institute Standard—Adopted 1911.
Weight 1 Cubic foot = 450 Pounds
Resistance 1 Pound-foot = 0.00144 ohm.

Nominal Diam. of Pipe.	Weight Per Foot, Exclusive of Bell.	Resistance Per Foot, Exclusive of Bell.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	*Pounds.*	*Ohm.*	*Amperes*
4	17.3	0.0000833	12.0
6	27.3	0.0000528	19.0
8	38.0	0.0000379	26.4
10	51.1	0.0000282	35.5
12	67.1	0.0000215	46.6
16	102.	0.0000141	70.9
20	140.	0.0000102	97.1
24	187.	0.00000770	130.
30	258.	0.00000559	179.
36	346.	0.00000416	240.
42	453.	0.00000318	314.
48	609.	0.00000237	423.

Standard Wreught Iron Pipe.
Resistance 1 Pound foot = 0.00181 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	*Pounds.*	*Ohm.*	*Amperes.*
⅛	0.24	0.000754	1.33
¼	0.42	0.000431	2.32
⅜	0.56	0.000324	3.09
½	0.84	0.000216	4.64
¾	1.12	0.000162	6.18
1	1.67	0.000108	9.23
1¼	2.24	0.0000808	12.4
1½	2.68	0.0000676	14.8
2	3.61	0.0000501	20.0
2½	5.74	0.0000316	31.7
3	7.54	0.0000240	41.7
4	10.66	0.0000170	58.8
6	18.76	0.00000965	104.
8	28.18	0.00000643	156.
10	40.00	0.00000452	222.
12	49.00	0.00000370	271.

Standard Steel Pipe.
Resistance 1 Pound-foot = 0.0021 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches	*Pounds.*	*Ohm*	*Amperes.*
⅛	0.24	0.000873	1.14
¼	0.42	0.000500	2.00
⅜	0.56	0.000376	2.66
½	0.84	0.000250	4.00
¾	1.12	0.000188	5.33
1	1.67	0.000126	7.95
1¼	2.24	0.0000937	10.7
1½	2.68	0.0000784	12.8
2	3.61	0.0000582	17.2
2½	5.74	0.0000366	27.4
3	7.54	0.0000278	35.9
4	10.67	0.0000197	50.8
6	18.76	0.0000112	89.4
8	28.18	0.00000745	134.
10	40.07	0.00000524	191.
12	49.00	0.00000428	234.

Discussion.

The President—Gentlemen, you have listened to a splendid lecture on an important scientific subject, delivered in a manner that has made it simple and comprehensible, and by a master mind. I will ask Mr. Gould to open the discussion.

Mr. Gould—Mr. President, our troubles in Boston from electrolysis seem to be disappearing. Looking over our records for the last four years, I find we have only had an average of one case of electrolysis on mains and three on services, 1909 to 1912. That means the cases that have been brought to our attention as distinct ones. Of course, we may have had damages to our pipes through corrosion, which did not have the other electrical indications. If you had asked me a month ago whether we had had any trouble, I should have said, "Practically none"; but last month in one of our suburban districts where the electric railroad is not a part of the Boston Elevated System, a service pipe was destroyed. It had been laid about 8 or 9 years. Tests showed that our pipe was an indefinite number of degrees negative to the rails; our voltmeter only registered 10 volts, and the hand came up with a thump on that side of the voltmeter. I have heard since that the engineers from the Metropolitan Water Department four or five years ago found a maximum of 90 volts in that district, but their pipes being negative to the rail, they did not worry very much about it. This service pipe was within 50 feet of the point where we tested, and was opposite the terminus of the electric road. I found afterwards that a telephone conduit passed under the service pipe at the point where it was destroyed. Undoubtedly the current went from the rails to the main, passed through the service pipe and from it to the telephone conduit, and was one of the best illustrations of that process of destroying pipes. The railroad people are investigating this, and I hope something will be done about it. One of Prof. Ganz's diagrams illustrates a trouble which we were investigating late last fall or early this winter. One of our holders, a steel tank holder, located above the surface of the ground, had a slight leakage through the bottom plates. There is a creek from the river in back of it, formerly salt water, now more or less fresh, on account of the dam of the Charles River Basin. The ground is saturated with marsh water, and, of course, there is salt in it. The power station is perhaps three-quarters of a mile above the river. We found that there was a light current passing from the pipes in the governor house to this creek. The quantity of the current we did not know. We simply made a voltmeter test in connection with the railroad officials, and up to the present time nothing else has been done to remedy the trouble. The inserting of insulating joints would be rather difficult at this point. The connecting of the pipes in governor house to plates sunk in the creek by copper wires may do some good.

Mr. C. J. R. Humphreys—I am inclined to think that after Prof. Ganz has finished a lecture on "Electrolysis" there is not very much that the rest of us can add that will be of any very great value. It is true that we did have considerable trouble in Lawrence from electrolysis four or five years ago, trouble on the sheaths of our underground electric cables and on certain of the gas services, particularly near the power plant. I called Prof. Ganz in to our aid, and he made a very thorough survey and very thorough study of all the conditions surrounding us. Some of the slides which have been thrown on the screen here to-day remind me very much of the incidents that we ran against in Lawrence; as, for instance, a current on a water main leading to a building by the water service pipe and then coming in contact with the lead sheath of an electric service, thus getting on our cables in the conduit. Such a case as that takes a good deal of time in tracing out, and I know in one of those cases the Professor had to put in a good deal of time before he found just where the current was getting out to our cable. I do not wish to speak of each particular instance, because I think they are all covered by what the Professor has said. There are certain principles, however, that seem worthy of consideration. When we first took up this matter and we were having considerable trouble with our underground electric cables, the suggestion was made to us by the trolley people that we should connect our sheaths to their return wires to their power house. The Professor and I discussed the matter thoroughly. It seemed as if that were the only remedy, but, after considering the matter, we both agreed on the proposition that we were not going to enter into partnership with the trolley company for the return of their stray currents. They had to take care of their own current; we were not going to enter into any partnership on these lines, and we held to that. Our troubles were lessened a good deal about that time by the fact that the trolley company was relaying its rails in a part of the city where we were having trouble, and we had this matter up with them. We notified them that we expected them to take care of their currents, that we were not going to do it, and in relaying their rails and trackage, they rebuilt on very substantial lines. They lessened our troubles quite a little, and then, of course, the Professor found, as I have just indicated, several cases where the current was coming on to our system, and where it could be done away with entirely or at least reduced. Now, I would like to call attention to the importance of the charts that have been shown or reproduced here, giving the record of the recording instruments, particularly the one which showed the load current for different days in the week and for different hours in the day, where you could see in the evening, as the peak load came on, it was reproduced on the coart, and in the morning and on Sundays. Now, I think that those charts are very important. The Professor has used them in Lawrence. Their importance is this, that it establishes without any doubt that it is trolley current. I do not see how you can get away from that. If you study the peculiarities of the trolley system, when the peak comes on and when it goes off, and you find those conditions reproduced on those charts, there is no use of the trolley road coming back and saying it is not its current. That is what they told us, of course, that it was our own current, not theirs, but with the system of those registering charts, and the study of the peak loads of the trolley system, you can establish that, of course, without a doubt. The only other point I wish to mention, is this: We do not seem to have now very much trouble from stray currents, but we have not stopped and said, "Well, stray currents cannot do us any harm." We have not stopped our investigations. On the contrary, all the work that we have been doing in the past in the way of survey is kept up, and the Professor visits us at least twice a year on a special trip, and during his absence, in the meanwhile, we test our electrical system along the lines which he suggests, the idea being this, and I think an important idea, to catch on to trouble just as soon as it occurs. At times we will, in this way, detect incipient trouble, and while it may not call for immediate action, we know something is going wrong. It cannot do any harm now, but it is something that has to be watched. Now, having that in mind, detecting what you might call these minor flows of current, we have points that we know will stand watching, and we do watch them, and we hope to catch the source of trouble before any serious damage is done. Electrolysis, I think, is one of those cases where "a stitch in time saves nine" by the systematic survey work carried on practically all the time.

Prof. Ganz—I would like to supplement what Mr. Humphreys has said by a few words. Electrolysis surveys do not always give a direct return for the money spent for them. Mr. Humphreys has brought out exceedingly well how they do serve to keep track of the situation. There is one other very important use of such surveys; namely, when damage results in the future they may be useful as a proof that the damage was caused by electrolysis. Very often after a pipe has been destroyed by electrolysis and has been replaced it is impossible to prove that electrolysis was the cause. Further, if a pipe owning company finds from an electrolysis survey that its piping system is endangered by electrolysis, it can notify the railway company of this fact; if then damage results in the future, the railway company cannot plead that they were not aware of the danger produced by their currents. It has also been my experience that when a railway company knows that the pipe-owning company is making electrolysis surveys, and is keeping watch on the situation, it will do at least some work towards improving the return circuit, thus reducing the danger from electrolysis.

The Secretary—I would like to ask Prof. Ganz or anyone else, if in a condition similar to this Charlestown exhibit the chemical composition of the material after it has not been destroyed but changed, can be used as a test to show whether or not the damage has been done by electrolysis or by some other corrosive agency? Most of the cases which I personally have had have been on old lines where there was a possibility of other corrosive agents, and I have asked that question several times without receiving thus far much satisfaction from the answers.

Prof. Ganz—I believe I can give a satisfactory answer, namely, that you cannot tell from the appearance of a corroded wrought iron or steel pipe whether the corrosion and destruction were caused by electrolysis. In the case of cast iron a graphitic material left as the result of the corrosion usually, but not always, indicates electrolysis. If corrosion from electrolysis is going on, it is perfectly possible, however, to make a suitable electrical test which will show conclusively whether or not stray electric current is leaving the pipe and is causing the corrosion. For this purpose we use an instrument known as an earth ammeter; we place this next to the pipe and connect it to a recording instrument, and obtain a 24-hour record of the current flowing from the pipe to the surrounding soil. This record will not only show the presence of current but will also indicate whether it has railway characteristics. If such current is found leaving the pipe it is certain proof that it must produce a corresponding amount of electrolysis. A test of this kind, together with the corroded pipe affords, in my opinion, the best possible evidence that we can have a corrosion by electrolysis. The corroded pipe by itself without any connecting electrical measurements will not ordinarily serve as complete evidence.

Mr. Shattuck—I was interested to hear the Professor say that there was no way of knowing whether a pipe was absolutely damaged by electricity or from some other source. Perhaps in contradiction to that I have heard recently that a professor in, I think, Swarthmore College, had made examinations under a microscope, and he claimed that in the case of a pipe that was destroyed by electrolysis the particles of iron were magnetic or stood out just as they do around a magnet. I was wondering if the Professor had made any experiments along that line, or if that was more theoretical than it was practical. Has the legal question been touched on?

The President—No, it has not.

Mr. Shattuck—I did not hear the paper. I have been advised quite recently that the proper action to take in cases of electrolysis if your electric company is not willing to go ahead and do something, is to file a bill in equity against a continuing trespass, and you will have a pretty good chance of sustaining an action under such bill. It brings it to a head quicker than anything else, and I believe it is the best legal practice to-day. It may be of interest to some of the smaller companies.

Prof. Ganz—I agree absolutely with the suggestion of Mr. Shattuck. An attempt to secure an injunction would rarely be granted because an electric railway is a public utility, and the courts will hesitate a long while before issuing an injunction restraining them from operating. Regarding the tests suggested by the Swarthmore professor for determining whether a given corrosion was caused by electrolysis or by natural causes, I would like to say that local galvanic action can produce currents which would produce electrolysis in which case the corrosion is not due to external stray currents, and yet the corroded iron must have the same appearance as if it had been produced by stray electric current. I, therefore, do not think that much can be hoped for from this test.

SASKATCHEWAN'S BRIDGE CONSTRUCTION.

Methods that are followed in the construction of bridges by the province of Saskatchewan may not be generally known, but it is the policy of the Government to endeavor to build all small timber bridges, reinforced cement bridges and cement bridge abutments during the summer months, as this class of work can be better performed during the warmer part of the year, while the erection of the steel bridges, which vary in length from 40 to 250 feet each single span, is usually undertaken during the winter months; such arrangement gives continuity to the work, so that in no part of the year is there any cessation of the work of bridge construction.

It is almost unnecessary to remark that the bridging of streams, especially in those portions of the province which only very recently were thrown open to settlement, but which are now rapidly becoming the centres of agricultural enterprise, is of even greater importance than the construction of graded roads, because, as a rule, the average prairie trails can be travelled without difficulty with average loads, and it is to such districts that a considerable amount of the attention of the department is devoted, in order to enable the farmers in the outlying districts to market their produce. This might be described as pioneer bridge work.

Another class of bridge is that which is constructed in order to complete the links in a main road selected for improvement either by the rural municipal councils or by the board of highway commissioners, and wherever the location warrants, especially on the main roads directly leading to a market town, such structures are of a permanent or semi-permanent type.

The third class consists of those bridges built to replace older structures, which have passed their age of usefulness. Generally the bridges which replace these latter are of a permanent type, that is, of steel and concrete, and last year saw fifteen of these bridges handled in this manner. At the time of writing a few of these works are still in progress, and it is satisfactory to note that the work of construction has not been delayed at any time during the severe weather of the early part of February.

At present there are seven bridge crews on the day labor basis in the field, working continuously, which is about half the number of crews usually employed during the summer months; in addition to these are the contractors who are constructing bridges under direct contract.

HIGH-POWER GAS ENGINES FOR JAPAN.*

By Frank C. Perkins.

The arrangement of the four gas engines in the Kamata gas operated power plant in Japan is noted in the accompanying drawings of the 2,130 h.p. gas engines in the English shops of the Lilleshall Company, Limited, at Oakengates, Shropshire. From these drawings may be noted the details of construction of the cylinders and valves of these high power engines of the Nuernberg design built in English shops for the Japanese government.

The Japanese officials recently determined to electrify the line of railway between Tokio and Yokohama and it was decided to generate the energy necessary by means of gas power, a power house b ing erected for this undertaking at Kamara near Yokohama.

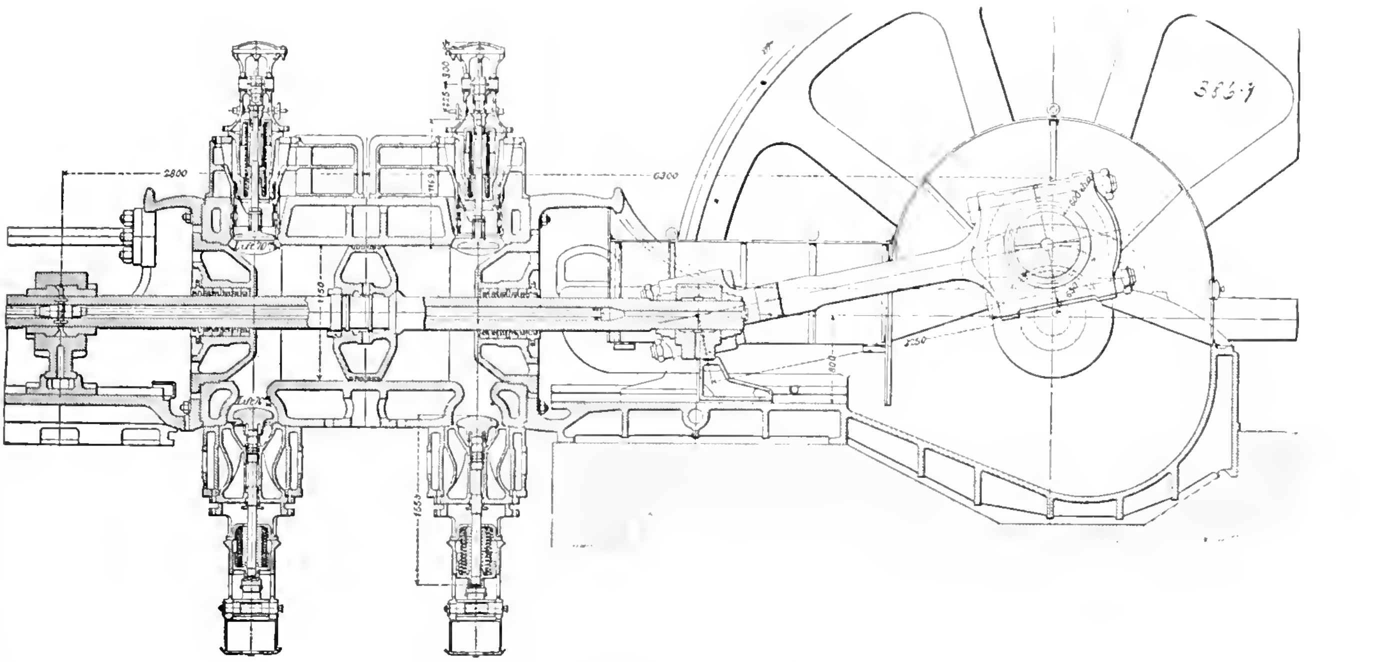
It will be noted that the station was designed to accommodate four gas engines each rated at 2.130 b.h.p. when running at 95 r.p.m. The gas producers were supplied by the Power-Gas Corporation of Stockton-on-Tees, England, and are located in a separate building. A complete plant for the recovery of the sulphate of ammonia has been provided and the sale of the sulphate, it is believed, will cover the whole cost of the fuel.

The engine house measures 166 feet in length by 90 feet in width with a forty-ton travelling crane to traverse it from end to end. It is said that the exhaust serves to provide a large part of the steam required for operating the Mond producers, into which it is necessary to pass about two tons of steam for each ton of coal gasified. There is an electric motor-driven centrifugal pumping plant provided for cooling the pistons and cylinders arranged in a pit to one side of the last engine on the right.

For starting there is a supply of compressed air under a pressure of 300 pounds per square inch provided, the two compressors being motor-driven and located near the water pumps for the piston. The compressors are cooled by a supply of water from the cylinder cooling main and deliver the air by a 2½-inch air main into receivers 48¾ inches in diameter by about 12 feet long, there being four located under the engine platforms.

On this gas engine it will be seen that the cold water enters near the hottest part of the cylinder, and is withdrawn at the coolest, and the inlet valves are nearly flush with the cylinder barrel. Each individual cylinder weighs 25 tons, and these cylinders are 1,200 mm. (47¼ in.) in diameter by 1,300 mm. (51⅛ in.) stroke. The engine was designed for a speed of 100 r.p.m. at which its output would be 2,600 to 2,500 b h.p., but at Kamata it is to run at 94 revolutions and generate 1,500 kilowatts current, this being equivalent to 2,130 b.h.p.

It will be noted that the whole of the weight of the pistons is carried by the cross-heads, thus reducing wear in the cylinder and at the blands. To this end the rods have a slight upward chamber, so that they are straight when loaded with the weight of the piston. The piston is bolted down to a conical seat by a fine threaded nut, the nut beds into the piston, and by means of a rubber joint makes a perfectly water-tight connection when screwed home.



Details of Cylinder and Valves of 2,130 H.P. Engine.

The supply of cooling water for the piston is conveyed through the interior of the piston rod, to which water connections of the swinging link type are provided at the centre cross-heads. At the central cross-head each rod has screwed on to it a cap, the swelled ends of which fit into a recess bored in the cross-heads, which is made in two parts, the upper forming a keep, which is firmly bolted to the lower. The water supply enters the rods by pipe connection which straddle the cross-head proper.

It will be observed that the junction piece between the cylinder is open at one side, so as to give ready access to the central cross-head and its water connections; and symmetry is secured by reinforcing this open side by a stout steel tie. The forward bed is made in two portions in order to facilitate the transport of the bed over the Japanese railways. The two portions are coupled together by link, shrunk into place, and the weight of the whole complete is 55 tons. The total engine weight, including the fly wheel, is 400 tons. The connecting rod is of the marine type. Forced lubrica-

*Abstract from The Gas Engine.

tion is provided for the crank pin which is 600 mm. (23⅝ in.) in diameter.

The shaft at the fly wheel seating has a diameter of 820 mm. (32¼ in.). The front cross-head is of nickel steel with the small end pins forged solid with it. There is secured to it a cast iron slipper lined with white metal and this is secured in such a way that the cross-head proper can readily be lifted clear and the piston withdrawn for examination or repair.

In the construction of this gas engine Siemens-Martin steel is used for the crank shaft, the main bearings for which have four part brasses of steel lined with white metal, and these are also arranged with forced lubrication. The glands are packed with cast iron rings turned slightly smaller than the rod, and split. Each is backed by a floating metallic packing kept tight by springs and the glands are lubricated by oil, supplied by forced feed lubricators.

It will be seen that the valves are operated by eccentrics mounted on the side shaft, and which is made in two parts coupled together by gearing, and in the gear box provision is made for the gears which drive the governor. The latter being provided with a speed regulator.

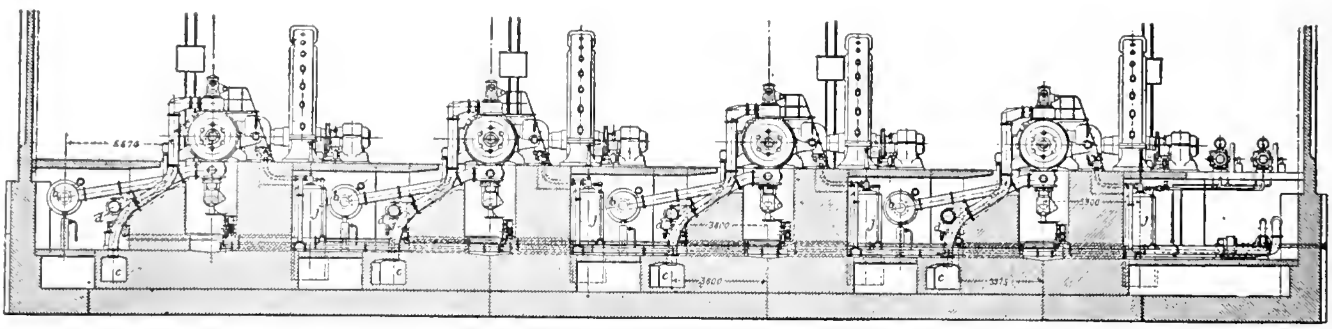
The side shaft runs in ring lubricated bearings and the inlet valves are mounted on the top of the cylinder. The eccentric rod from the side shaft is coupled to the upper of a pair of "rolling" levers, as shown, and between the two is a sliding block, the position of which is regulated by the governor.

the supply going to these. Each water outlet is fitted with a regulating cock and a thermometer, so that the supply to each part can be adjusted with great nicety, and water economized. A single large cock is provided on the supply pipe, by which the water can be shut off when the engine is stopped and the regulating cocks do not, therefore, require to be touched.

It is said that the supply of water is at the rate of about 8 gallons per b.h.p. hour, and the temperature rises from 60 degrees to 105 degrees Fahr. Cooling towers are provided by the use of which the actual loss of water is reduced to 2 pounds per b.h.p. hour. The ignition system is unique, as each cylinder is provided with three low-tension ignition plugs, operated by small electromagnets and the current supply is taken from storage batteries.

It is of interest to note that the engine is started by compressed air, admitted through independent ports, with valves which are operated by the side shafts. To each engine is coupled a 1,500-kw. alternator having its pole pieces mounted direct on the rim of the fly wheel, which was constructed by the Lilleshall Company, its weight being about 100 tons. The rim is compound, being cast round a dovetailed strip of soft steel, which is provided to take the magnetic flux between the poles. The kinetic energy of the wheel at the running speed of the engine is sufficient that the cyclical variation in speed at full load amounts to less than 1 in 250, it is claimed.

As to operation, it is said the cost per kilowatt is $0.046,



Showing Arrangement of Four 2,130 H.P. Engines in Power Plant, Japan.

As the block is near the fulcrum of the lower of the pair of levers, the valve has its maximum opening. A rotable sleeve fitted with ports is provided inside the valve casing and it moves with the main valve, and by twisting round the spindle of the latter the relative proportions of gas and air drawn in can be adjusted to suit the quality of the gas being supplied.

It is stated that the whole of the valves and their casing can be removed bodily on unscrewing a few nuts. The exhaust valve is operated by the same eccentric as the inlet valve immediately above it. As before, a pair of rolling levers are used to secure the desired rapidity of opening and closing, but no adjustment is required for varying the amount and time of opening, as is necessary at the inlet valve.

The valve is mounted complete in a casing independent of, and merely bolted to the cylinder. The casing is thoroughly water-cooled but the valves themselves are not, since it is found that with efficient cooling of the seats this complication is unnecessary. There are oil catchers which retain all the oil which escapes, and conduct it to a filter below the engine, and from this filter it is pumped back to the tank.

The cooling water is supplied at a pressure of about 16 pounds per square inch, but the accelerating forces to which the pistons are subject make a higher pressure necessary for

based upon the working of a 4,500-kilowatt central power station, supplying four gas engines, of 1,500 kilowatts capacity (one as a spare) direct coupled to three-phase generators, the gas plant consisting of three units, of 2,500 kilowatts capacity each (one as a spare); the plant working continuously at a 60 per cent load factor:

$$\frac{4{,}500 \times 60 \times 24 \times 365}{100} = 23{,}652{,}000 \text{ kw. hours per annum.}$$

It is maintained that the two generator sets would be capable at full load of coping with the load, but for the purpose of the estimate, and to get a fairer idea of the running cost, three engines have been assumed to be working. The consumption of gas per b.h.p. is taken at 106 cubic feet or 156 cubic feet per kilowatt hour (half load consumption).

It is held that the total cost of about ½ cent per kilowatt hour includes interest and depreciation, and is based upon the engine running at about half load. The cost of sulphuric acid has been taken at double what it can be bought in England to allow for the freight in Japan. Ammonium sulphate plays an important part as a manure in agriculture, and this was one of the main reasons in deciding the Japanese government to install a gas plant, and thus support their farmers without having recourse to foreign manures.

WATER TREATED WITH CHLORITE OF LIME AGAINST TYPHOID FEVER AND ITS EFFECT UPON VEGETATION.

During typhoid epidemics the water supply of cities is temporarily treated with hypochlorite of lime in order to destroy the active typhoid bacilli in the water and thus prevent the spreading of this disease by means of impure water.

Coincidentally with this practice, nurserymen and others using this treated water for their greenhouse and other plants, stated that they noticed a peculiar failing in the vigor of their plants, and thus were anxious to obtain advice whether this water may be injurious to plant life. Considering the great germicidal properties of this preparation, it was thought probable that injury might also result to higher plants from its use.

For this purpose the Dominion Chemist, Mr. F. T. Shutt, M.A., and Mr. H. T. Gussow, Dominion Botanist, began a series of experiments in February, 1911, which were continued with a view of disclosing any facts bearing on the subject.

They obtained a number of plants which were suspected to be failing in health owing to their being treated with chlorinated water. Three plants of carnations and three of Hybrid roses of this kind were subjected to the following treatment:—

1. Potted into new soil, watered as required with snow water only.

2. Potted into new soil, watered as required with chlorinated water (0.26 p.p.m. available chlorine).

3. Potted into new soil, watered as required with chlorinated water, but boiled for fifteen minutes.

4. Potted into new soil, watered as required with chlorinated water plus 1 lb. of soot per 3 gallons of water.

5. Roses grown on the farm used as check plants treated in the same manner with chlorinated water.

The plants were very carefully watched and kept under the same condition of temperature and culture. After three months had elapsed no difference whatever could be noticed in any of the plants. The roses blossomed freely throughout, the carnations, however, hardly recovered, having been transplanted while practically in flower. The check plants subjected to the different modes of treatment showed not the slightest signs of any injury.

Another experiment was conducted to test the effect of chlorinated water on the germination of seeds. Various strengths ranging from 0.05 to 10 parts per million of available chlorine were used. Six varieties of wheat were employed, the seed being soaked in the freshly made-up solutions, and an equal number in distilled water. (Time 12 hours).

All samples were sown on the same day. Germination was found to be uniform throughout; no influence could be observed on the energy of generation or in the development of the young plants. Later on, a series of experiments was started with barley and oats without any sign of injury, or even retardation. The plants were grown until in flower, when the earth was washed away and the plants, root and all, were carefully dried in the air and then weighed. Although slight differences in weight between plants of the same series occurred, such did not indicate that there had been any injurious influence exerted by the chlorinated water.

Without going into further detail, Mr. Shutt and Mr. Gussow, as a result of this investigation, conclude that the water supplies, as ordinarily treated with hypochlorite of lime, have no injurious effect, direct or indirect, upon cultivated plant.

A NOTABLE OVERLOAD BOILER TEST.

A recent test of the No. 12 boiler in the plant of the Narragansett Electric Lighting Company, Providence, R.I., produced for eight hours very nearly 250 per cent. of boiler rated horse-power at an over-all efficiency of boiler and grate of 73 per cent. This test, which was witnessed by James D. Andrew and Fred B. Freeman, of the Boston Elevated; Charles W. Clarke, of Stone & Webster Engineering Corporation; Messrs Arnold and Sarkey, of the Westinghouse Machine Company; M. Alpern, of the American Engineering Company; H. O. Breaker, of the B. F. Sturtevant Company; B. F. Allen, of Westinghouse-Church-Kerr & Company; Mr. Brown, of the Foster Superheater Company; Wm. Pastell, superintendent of the power station of the Rhode Island Company, and M W. Kern, of the Narragansett Electric Lighting Company, was for the purpose of determining the capacity of a Riley self-dumping, underfeed stoker of five retorts, which had been placed under the boiler.

The boiler, which was twelve years old, is a B. & W., 12 tubes high, 18 tubes wide, and 16 tubes long. No special effort was made to prepare it for this test. As a matter of fact, its companion boiler in the group of two was cold. The boiler was of such a size that a stoker of 7 retorts could have been installed under it, which would have resulted in the burning of more fuel and a considerable increase in the capacity obtained. As the stoker is of the self-dumping type, working automatically, there was not a periodic dumping which is a necessary feature of the other types, hence the steadiness of the steam pressure (174.1 lbs. average) and other operating conditions. The fire appeared to be in the same condition from one end of the test to the other, all clinker being broken up automatically during its process of formation, and the boiler was kept on the regular line for some hours after the test.

The total amount of coal consumed was 25,450 pounds, or an average of 3,181 pounds per hour. The water fed amounted to 251,170 pounds, or an average of 31,396 pounds per hour, thus giving an evaporation of 9.87 pounds of water for each pound of coal. The water was fed at a temperature of 196 deg. F., and the equivalent water evaporated per hour from and at 212 deg. F. was 33,437 pounds per hour, or a total of 969.2 boiler horse-power developed, which was 248.5 per cent. of builder's rating. The equivalent evaporation per pound of coal as fired thus figures out at 10.51 pounds of water, and the factor of evaporation is 1.055.

The coal analysis showed 74.13 per cent. fixed carbon; 14.95 per cent. volatile matter; 6.52 per cent. ash, and 4.40 per cent moisture. The calorimeter test showed the heating value to be 14,600 B.t.u. when dry, or 13,957 B.t.u. as fired. The coal was thoroughly consumed, as is shown by the flue gas analysis, which gave 16 per cent. CO; 0.12 per cent. CO; and 2.7 per cent. oxygen

At one time during the test a piece of 4 by 6 timber was purposely dropped into the centre hopper to determine the effect upon the stoker. This timber, of course, blocked the plunger in that hopper and sheared the safety pin located on the connecting rod. The plunger was then automatically withdrawn from the stoker upon the return stoker of the connecting rod and left at its outermost position. Upon the removal of the obstruction and the insertion of the new pin, all of which was done without stopping the stoker, operation was resumed as if nothing had happened. Of course, however, the feed of coal into the middle retort was interrupted until the adjustment had been made. The horse-power used by the blower was determined as 20, while 1.4 horse-power was used to operate the stoker. Separate motors were used to drive blower and stoker.

EFFECTS OF ELECTRIC CURRENTS ON CONCRETE.

By E. B. Rosa, Burton McCollum and O. S. Peters.

This paper deals with the results of an extended series of experiments carried out at the United States Bureau of Standards during the past two years. The investigations consisted of three parts, as follows: (1) Laboratory investigations relating to the nature and cause of the phenomena produced by the passage of electric current through concrete; (2) investigations in the field with a view of establishing the probable extent of the danger in practice, and the circumstances under which the trouble is most likely to occur; (3) a study of the various possible means of mitigating trouble from this source leading to specific recommendations. The experiments were for the most part carried out on cylindrical specimens six inches in diameter and eight inches high with an electrode, usually of iron or other metal, imbedded in the centre, serving as either an anode or cathode in different cases. These specimens were immersed in water in jars surrounded by a sheet-iron electrode, which served as the other terminal.

Anode Effects.—The tests were carried out with a great variety of voltages, ranging from 2 volts to 115 volts, with the imbedded electrode anode. On the higher voltages, which included all cases having more than about fifteen volts per specimen, there was exhibited the familiar phenomenon of cracking of the concrete and rapid corrosion of the imbedded iron, most specimens cracking within twenty-four hours under a current flow of from 0.5 to 0.8 ampere-hour.

On the low-voltage specimens, however, where the voltages ranged from 2 to 15 volts, very different results were obtained. At the outset of the investigation 90 specimens containing iron electrodes were placed in circuit on fifteen volts and watched for a period of seven and a half months. At the end of that time a number were broken open, the amount of corrosion determined, and the general condition of the concrete noted. A most conspicuous feature of the results of this test—and a very surprising one in view of the results previously obtained at higher voltages—is the fact that cracking almost universally failed to occur. Of the 90 specimens under test only three had cracked at the end of seven and a half months, and these were shown to be abnormal specimens. In practically all cases, also, there was no appreciable corrosion of the iron. It is important to note that the total number of ampère-hours per square inch of imbedded electrode surface in the case of the low-voltage specimens is considerably larger than for the high-voltage specimens, the former averaging 2.6 ampère hours and the latter only 0.83 ampère-hour. It is evident, therefore, that the quantity of electricity that passes through the specimen does not alone determine the amount of damage that it may do, but that the rate at which the current flows is also an important factor. Moreover, it is evident from these observations that the rate at which damage occurs decreases with decrease in voltage much more rapidly when the voltage is lower, since in the present instance a reduction of voltage to one-fourth of the value used in the high-voltage tests enabled the specimens to run with little or no damage for a period over 200 times as long as was required to destroy the specimens in the higher voltage. It has been shown that this difference in the effect of high and low voltages is fundamentally due to a difference in temperature. So long as the heating effect of the current is insufficient to raise the temperature of the specimen to about 45° or 50° Centigrade, little or no corrosion results, but if the current is strong enough to raise the temperature materially above that point, rapid corrosion sets in.

Cathode Effects.—When the imbedded electrodes are made cathode, different effects are produced. In this case there is no tendency for the iron to corrode, and the conclusion has been largely accepted that when the current flows from the concrete to the iron no effects were produced. It was found, however, that after such specimens had been in circuit for several months with the iron cathode the bond between the iron and the concrete was practically destroyed. On laying the specimens open it was found that the entire region surrounding the cathode for a distance of one-sixteenth to one-fourth of an inch from the surface of the metal was considerably darker in appearance than the main body of the concrete, and was very soft. The cement here could be shaved off with a knife like soft soapstone.

Experiments with concrete containing no reinforcing material showed that the flow of comparatively heavy currents through the concrete produced no appreciable effect on its mechanical properties. The effects noted above are, therefore, solely electrode effects, and the softening of the cement at the cathode is attributed to the concentration of sodium and potassium hydroxide near the surface of the cathode, and it is this that causes the softening of the cement. The cracking of the concrete when the iron is anode is due to formation of oxide of iron, and the swelling action thus gives rise to a mechanical pressure which cracks the specimen. The pressure thus prduced was measured in several instances and was found to reach values of over 3,700 pounds to the square inch.

Rise of Resistance of Concrete.—It was found that in all cases the resistance of the concrete rose greatly, due to the passage of electric current, the rise being greater in anode specimens than in cathode specimens, the former showing an average increase of 137 times the original value at the end of seven and a half months, and the latter showing an average increase of fourteen times the original resistance at the end of about the same period.

The addition of a small quantity of salt to the concrete produced very marked effects. Two or three per cent. of salt added to the water used in mixing the concrete caused the anode specimen to be destroyed very quickly, even on very low voltages, because of rapid corrosion of the iron, and also greatly increased the rate at which the softening of the cement at the cathode progressed. The addition of salt likewise reduces the initial resistance of the concrete, and, more important still, prevents the rise of resistance which otherwise takes place under the influence of the electric current.

In discussing the possibilities of trouble from electrolysis in concrete structures under practical conditions, it is pointed out that, while the dangers from this source have often been greatly exaggerated, the possibilities of trouble are nevertheless sufficient to make precautionary measures necessary under many circumstances. A number of possible precautionary measures are discussed in the last section of the paper.

That development is proceeding steadily all over the lower mainland and on Vancouver Island is shown by the announced policy of extension and expansion of the British Columbia Telephone Company. Officials of the company toured Vancouver Island last week and will make extensions to outside plant in nearly all of the exchanges on the Island. Improvements have been in progress in Victoria for a couple of years past, and large works are now in hand there. The fact that the smaller exchanges throughout the Island show growth indicates a settlement on the agricultural areas, something that is badly needed in this province. In Point Grey, the company is expending much money, and plans this year to have telephones all over the Burrard peninsula.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, APRIL 24, 1913. No. 17.

CONTENTS OF THIS ISSUE.

"MODERN METHODS OF ILLUMINATION."

Modern methods of illumination have had a great deal of study and investigation devoted to them during the last few years. It has been well justified by the admirable results obtained, and has been brought about not merely for commercial reasons, but from the necessity of protecting human eyesight from the intensity of illumination due to modern inventions in the field of illumination.

On another page of this issue will be found an article dealing with the use of Tungsten lamps in mills and factories. It is the invention and commercial advantages of such methods of illumination as the metal filament electric lamp that has helped along and adds stimulus to the solving of illuminating problems.

Whether the light was close to the eyes or in the line of vision or not was a matter of no great moment. In the successive improvements from the tallow candle through the oil lamp, yellow flame gas jet, incandescent gas mantle, and carbon filament electric lamp the conditions as to color and brilliancy were such that the available brilliancy was too small to cause discomfort, and, within limits which were fixed in the case of combustion lights by annoyance from heat, smell, and fumes, and in the case of carbon lamps by convenience of location, the source of the light was brought as close to the work to be performed as possible. The change from the more or less "mellow" light of carbon lamps to the intense white brilliancy of incandescent metal filaments had the immediate effect of raising complaints against the new light on the score of hurt to the eyes. The greatly improved efficiency as regards current consumption was not to be neglected, however, so that means were taken to mitigate the cause of complaint by placing the lights further away from the working plane. This movement had a retrograde aspect, however, since it necessitated the use of lamps of higher candle power, though still of greater efficiency, to maintain the previous intensity of illumination. The next step, therefore, was to search for means by which to reproduce this intensity without using lamps of higher power than before, and the increased use of enamelled tin and opal conical shades was the result. This has gone on till we find that in the lighting of shops, offices, warehouses, showrooms, and passages all that is wanted in the majority of cases is that a predetermined intensity of illumination shall be available at the working plane with a minimum current consumption and cost of installation. Shades and globes, on the other hand, are largely used in hotel lounges, restaurants, and private houses, where the sacrifice by diffusion of a small amount of the available light need not be considered and where appearance must not be sacrificed to first cost.

THE PANAMA CANAL AND ITS INFLUENCE ON THE COAST CITIES OF BRITISH COLUMBIA.

Nothing has probably occurred in the recent history of the continent of America calculated to exercise a more profound influence on the future of British Columbian cities than the coming opening of the Panama Canal. Much has been said in this regard by many writers. It would seem that the benefits flowing to the cities through the opening to traffic of this gateway will be very much as the people decide to make them.

They have a very strong strategical position. They have a country teeming with natural resources. They

have the best natural harbors on the whole stretch of coast line running from Panama to Alaska—and it might be thought, in consequence of this, that their future is so well assured that they could afford to cease troubling about it. It would be the part of wisdom, however, for them to leave nothing undone to take full advantage of the splendid opportunities which are about to present themselves through the opening to traffic of the Panama Canal.

Capt. Logan, of Victoria, speaking on the subject, inclines to the conviction that three things will probably happen immediately on the opening of the Panama Canal which will have a direct effect upon the ports of British Columbia. First, there will be an increase in the volume of shipping; second, there will be an influx of immigration to the Province; third, there will be a material increase in the permanent population of the cities.

One of the first effects on Vancouver Island of the opening of the Canal will be to stimulate renewed agitation for the bridging of Seymour Narrows. No one disputes that, given all-rail connection with the mainland, Victoria would occupy a position of superiority and advantage over the other cities of the North Pacific seaboard.

In respect to immigrants, the continuous journey without change in a voyage of less than a month's duration and at a fare which will be practically little more than is now charged for passage across the Atlantic will assuredly result in bringing West a number of those now in the United Kingdom and elsewhere in Europe who will be drawn by the opportunities. It will be probably more comfortable for the emigrant from Europe whose destination is the Prairie Provinces to travel via the Canal than across the Atlantic direct and then by rail west. There will follow a stimulus to Island and mainland development, but this will not take the most advantageous course unless they have formulated some policy before the influx begins.

Victoria and the Island of Vancouver have a great future, and if the bridging of Seymour Narrows is ever accomplished Vancouver and the other cities on the coast will have a hard time to hold their own in rivalry.

TRANSMISSION OF ELECTRIC ENERGY IN BULK UNDER WATER.

The transmission of electric energy in bulk by cable under water is a problem that has not yet been seriously tackled, but the first sign of a possible new era is seen in the project now in course of realization for sending electric current from the Trollhattan Waterfall, in Sweden, to Denmark by submarine cable. The occasion for it has arisen through the need on the part of the municipality of Copenhagen for a reliable source of energy for its electric tramways. This point was forced on the municipality's notice at the time of the coal strike in Great Britain, as they have been accustomed to obtaining a fuel supply from there.

It would now seem that only the consent of the Swedish Government is needed and a contract will be entered into for the construction of a high-voltage transmission line from the Waterfall Trollhattan, in Sweden, along the coast for 160 miles and then by submarine cable across a ten-mile sound to Elsinore, on the Danish island of Zeeland. A central distributing station will be erected at Elsinore, and a current will be transmitted to Copenhagen, fifty miles south, and to other industrial centres of the island.

THE NEW CAPITAL OF AUSTRALIA AND ITS PUBLIC BUILDINGS.

Canadian architects, in common with members of the profession in all parts of the world, will shortly be given an opportunity to compete in the designing of the principal public buildings for Canberra, the capital city of Australia, which was officially designated a few weeks ago. Canadian Trade Commissioner D. H. Ross has forwarded to Ottawa from Melbourne, Australia, a report on the subject, in which he states that the sites for the principal buildings of the capital having been determined, it is proposed that competitive designs shall be invited from all parts of the world. The building sequence contemplates practically no interruption, and among the first public structures to rear themselves on the site will be the governor-general's residence, courts of justice, police buildings and jail, administrative offices, military depot and offices, schools, observatory, medical and hospital buildings, railway station, prime minister's residence, accommodation for members of parliament, post-office, printing office and town hall. Other buildings will also be erected, such as a state house and educational institutions.

ELECTRIC AND STEAM WINDING.

Electric winding at the gold mines on the Rand has made rapid strides during the last two years in spite of the fact that coal is both plentiful and cheap. Several of the large mining concerns have their own generating plants, but as a rule the power is purchased from the Victoria Falls and Transvaal Power Company. Those companies which generate their own power mostly use the Ward-Leonard system and those which use purchased power employ the three-phase system, but there are prominent exceptions.

In the Brakpan Mines, for example, both methods are at work, the three-phase generally for winding rock and the Ward-Leonard principally for men and materials. About 50,000 tons of ore are hoisted monthly from a depth of 3,825 ft.

On the whole, the costs for stores, repairs, and maintenance of electric hoists inside the engine-house are considered to be lower than those for a similar sized steam plant. The highest efficiency of coal at the lowest selling price for the best local quality would enable 816 ft. tons to be lifted by steam at a cost of a penny. In the instance quoted the electric winders lifted 260,727 tons of rock from a depth of 3,825 ft., and handled men and tools amounting to 40 per cent. of the total work performed, for a power cost of $20,000, and the work done in rock hoisting alone works out at 960 ft. tons for one penny as compared with 816 ft. tons for steam.

A better illustration may perhaps be afforded by taking the actual steam and electrical power costs at the Bantjes Consolidated Mines. At the No. 1 shaft a Grant-Ritchie winding plant is installed with 6 ft. drums driven through single-reduction gear ratio 127 to 42 by a 600 horse-power three-phase induction motor working at 2,000 volts and 362 r.p.m. From October, 1911, to July, 1912, inclusive, this particular hoist raised 133,684 tons and used 231,392 units, the units consumed per ton hoisted averaging 1.73, or, at 1.1234c. per unit, 1.944c. per ton hoisted. With spares, renewals, and labor the total cost was 2.32c. per ton. These engines were run by steam from November, 1910, to April, 1911, and, including coal, wages, and maintenance charges, the average cost was $498.52 per month. The average cost for electrical winding, including maintenance charges, from May to September was $363 a month.

ABSTRACT OF REPORT ON THE CITY OF TORONTO TRAFFIC REQUIREMENTS.

The report of B. J. Arnold, of Chicago, and T. W. Moyes, of Toronto, who were engaged by the latter city to examine into and report on street railway traffic requirements, has now been made public. The report itself has been finished for some time, but the city had refused to make its contents public.

The report as boiled down reads:—

Car congestion can be overcome by re-routing.

Overcrowding can be largely eliminated by the use of extra cars.

Track mileage has increased only 2.4 per cent., while the population increased 9 per cent.

The Toronto Railway Company spends 57.46 per cent. of gross income on operating and other expenses, while other companies spend 70 per cent.

Toronto spends less than 1 per cent. in maintenance of track and roadway. Chicago spends 2.27 per cent.

Thirty-five per cent. of the company's track should be rebuilt.

Faster service should be provided and trailers eliminated.

Equipment is so operated as to produce 28 cents per car mile, while expenses are 13 cents.

Toronto has 113 miles of single track. An addition of 127 miles should be made, which, with equipment, would cost $8,762,000.

Tubes are not needed at present, if better surface equipment is provided.

Motor 'busses will not meet the situation.

That the city has outgrown its transportation facilities is emphasized. They say there are few difficulties in the way of giving needed relief. Co-operation of the varied railway interests is suggested as a means of affording quick relief. "Car congestion could be overcome by re-routing a few lines in the congested district, and over-crowding could be largely eliminated by the use of extra cars during rush hours." They recommend faster time schedules, and say an improved service could be thus given without an additional car.

Cross-town lines and extensions into the outlying territory are recommended The experts are opposed to subways, which are not warranted.

Ordinarily, for a system covering an entire city under Toronto's conditions 70 per cent. of the income is required to operate and to meet the taxes and depreciation. The reports of the Toronto Railway Company for 1911 show that these items, exclusive of renewals, consumed only 57.46 per cent. of the gross incomes. This demonstrates the ability of the company to increase its service materially without sacrificing fair return from business, even if a liberal allowance is set aside for renewals.

The company's annual report to the Ontario Railway Board shows the total expenditure for maintenance to be only 8.58 per cent of the gross receipts. The average of all Chicago companies for 1910 was 8.6 per cent. But Toronto spends only .926 of 1 per cent on maintenance of track and roadway, while Chicago spends 2.27 per cent for the same purpose. The statement of the Toronto Railway Company shows no expenditure for renewals, which alone should be from 8 to 10 per cent. of the gross receipts Thirty-five per cent. of the company's tracks should be rebuilt and other improvements made. Fifteen to eighteen per cent of the gross receipts should be spent in upkeep, after the property is put in first-class operating condition.

Schedule speed of the cars should be increased, the report states, and trailers should be eliminated. The public and the crews of the cars should be more alert. Faster cars should be provided, and improved turnouts and curves installed.

The Toronto Railway Company is at present operating 113 miles of track over an area of about 10½ miles in length, east and west, by 3¾ miles in the extreme width, north and south. The business is conducted with 642 cars, 569 double-truck and single-truck motor cars and 73 trailers. The equipment is so operated as to produce 28 cents per car mile, notwithstanding the low fares, while the expenses are about 12 cents per car mile, a most favorable showing for surface lines in any city.

The total cost of the proposed additions to the present system for 127 miles of new track, 600 pay-as-you-enter cars, additional car-houses, sub-stations and other equipments, is estimated at about $8,762,000.

If the civic car lines and those of the Toronto Railway Company are to continue to be operated under more than one management until 1921, a terminal in the business section of the city is recommended. "Without proper outlets," the report states, "isolated lines generally lead a precarious existence and prove a disappointment."

The estimate of the cost of a complete new surface and subway system is $10,473,000. The present traffic would not warrant this expenditure, the experts state, but they admit that a subway system might be a financial success if the growth of population north of St. Clair Avenue and Danforth Avenue increased greatly.

The following radial lines are recommended: Yonge Street, Cottingham Street to the north end of the new city limits, with temporary arrangements for transfers with the Metropolitan Railway; double tracks to Eglinton Avenue this year, with double rails owing to the difference in gauge.

Davenport Road from St. Clair Avenue and Keele Street to Dupont and Bathurst Streets, to be double-tracked in 1916.

Dundas Street, from Keele Street to Lambton, double track in 1914.

Weston Road, from Dundas Street to Mount Dennis (Eglinton Avenue), 1916.

Lake Shore Road, as a terminal and outlet for lines west of Sunnyside Avenue, to be operated to the Humber as part of the King Street line as soon as the gauges are equalized.

Kingston Road, from King Street north-east and east to the city limits, to be double-tracked by 1916.

WORK ON ATLANTIC DIVISION OF C.P.R.

Word comes that Mr. W. Downie, general superintendent of the Atlantic division of the C.P.R., has issued the following statement in respect to the expenditure on maintenance of way, bridges, rails, culverts and the like on the main line from Megantic to St. John, not counting branches for the two years, 1911-12:—

	Capital.	Maintenance.	Total.
1911	$220,142	$528,985	$749,127
1912	348,417	674,663	1,023,081
Total for two years			$1,772,208

Mr. Downie pointed out the large yearly increase in these expenditures and the big total reached last year as compared with the expenditure in 1911, and said that during the last nine years the entire division from Megantic to St. John had been relaid with 80 to 85-lb. rails, while the line was ballasted throughout. Every wooden bridge taken out and replaced by steel with masonry or concrete and wooden culverts were replaced by concrete ones.

PANAMA WATER SUPPLY.

The committee, consisting of Mr. H. H. Rousseau, chairman; H. O. Cole, George M. Wells, James T. B. Bowles, and Louis Ernst, appointed to consider plans and make recommendations for a permanent water supply for the Pacific end of the canal, has submitted its report, and same has been approved by the chairman.

The plans contemplate the continued use of the Rio Grande reservoir, and the increasing of its capacity by raising the dam to elevation 265 feet, or 27 feet above the present crest. It is believed that with the increased capacity the reservoir will supply at least 6,000,000 gallons of water a day, except in years of minimum rainfall, such as 1888 and 1912.

It is further proposed to use the Camacho reservoir as an auxiliary supply. The surface of the water in this reservoir at high level is 100 feet above that in the Rio Grande, so that a gravity flow between the two reservoirs could be maintained by means of a pipe line, or by a small concrete-lined aqueduct laid around the main hills for a distance of about 13,000 feet. It is estimated that about 1,500,000 gallons of water a day would be added to the Rio Grande supply in this manner. Before final adoption of the Camacho pipe line, the committee recommended that an estimate be made of the cost of laying the line, as compared with an estimate of the cost of pumping the same amount of water a day from Gatun Lake.

Assuming that 7,500,000 gallons of water a day might be obtained from the above sources, the committee turned its attention to the matter of a further supply. The possibility of procuring water from the Pedro Miguel and Cocoli Rivers was discussed, but the idea was abandoned in favor of Gatun Lake.

The plan of pumping water from the lake at a point on the west side of the canal, just north of the entrance to Pedro Miguel Locks, would involve the installation and operation of electrically driven pumps, but it would provide an absolutely certain supply during all months of the year, and would take care of a consumption far beyond the present estimate.

The consumption will probably not be less than 8,000,000 gallons a day when the canal opens. In view of future expansion, the committee recommended that the maximum normal supply should not be less than 12,000,000 gallons a day, and that the purification plant, pump station, and accessories be designed not only for that amount, but that provision be made for their future extension and enlargement without interference with the continuity of the supply.

The experience gained during the past six years, and particularly during the last year of the Agua Clara plant at Gatun, conclusively indicated in the minds of the members of the committee that the stream waters of the Isthmus yield readily to aeration, and aluminum sulphate treatment, followed by sedimentation and sand filtration. Heretofore, little attention has been given to the bacterial efficiency of the treatment, because practically all the water used for drinking purposes has been taken from uninhabited watersheds, with very little risk from contamination. In the proposed new water supply, the use of Gatun Lake water makes the matter of bacterial efficiency an important one. It is believed that a properly designed purification plant, with aeration and sedimentation, using aluminum sulphate, followed by rapid sand filtration, will take care of such water, but to provide against the possible contingency of pathogenic bacteria getting into the filtered water mains, it is proposed to use a bleaching agent—hypochlorite of lime—in addition to the aluminum sulphate, this agent to be used only when the daily analysis of the water indicates the presence of B. coli. The cost of this treatment would be small.

The committee considered the relative merits of pressure filters, as compared with the rapid mechanical gravity filters. It was shown that the first cost would be less, and that there would be an approximate saving in head of from nine to 15 feet by the adoption of the mechanical gravity type. It was further shown that filters of this type are rapidly supplanting those of the pressure type. The committee recommended their adoption.

It was believed that in using both the present 20-inch and 16-inch mains from the Rio Grand reservoir into Panama, the best plan would be to install pumps on these lines just south of the proposed purification plant to act as "boosters" to the gravity head available, these pumps to be designed to deliver the maximum supply south of Corozal, with a terminal pressure practically zero at some point near the present low level reservoir at Ancon. At the latter point, it is proposed to install a second "booster" station with pumps directly on the main to lift water to the low and high level reservoirs. This line would be by-passed, so that the pumps could pump directly into the mains fed from the above reservoirs. All pumps and stations would also be by-passed, so that in case of trouble to the pumps, the head due to gravity would deliver some water through the mains. The "booster" pumps will obviate the necessity of laying an additional feeder line, at least until the estimate of 12,000,000 gallons of water a day is exceeded. "Booster" station No. 1 would probably be located on the west bank of the canal, north of Pedro Miguel Locks, and would contain the supplementary pumps furnishing Gatun Lake water to the purification plant. "Booster" station No. 2 would likely be situated at some point near the present pump station at Ancon.

At the present time there are at Ancon two high pressure reservoirs, each 1,000,000 gallons capacity, one situated on the east side of Ancon Hill at an elevation of 295 feet above sea level, and the other on a knoll back of Hotel Tivoli, at an elevation of 138 feet. The committee was of the opinion that additional high pressure storage is necessary, and recommended the construction of a new 1,500,000-gallon reservoir immediately adjacent and connected to the present high level reservoir on Ancon Hill.

There is installed in the masonry of the emergency dam at the north end of Pedro Miguel Locks, a 24-inch diameter cast iron main carrying the water from the Rio Grande across the locks. It was the opinion of the committee that, as a measure of safety, and to provide for a possible future increase, an additional cast iron main, 30 inches in diameter, should be carried across the locks to a junction with the present 16-inch and 20-inch water mains.

The committee investigated a number of sites with reference to the location of the proposed purification plant, but refrained from making a recommendation, except that the plant be situated at the best point available on the west side of the canal, north of Pedro Miguel Locks.

The committee recommended that such work be done as will make the old 16-inch main continuous from the Rio Grand reservoir to Panama, and that it be cross-connected to the new 20-inch main throughout its length.

In view of the fact that the elevation of the purification plant, the size of the "booster" pumps, and finally the quantity of water that the mains may be expected to deliver in Panama depends on the correct value of the coefficient of friction for these lines, the committee recommended that friction tests be made, and that the results obtained be adopted in connection with the computations involved in the design of the different plants.

THE PROBLEM OF THE STEEL RAIL.

The problem of the steel rail is, as it has been for years, a very real one. In this connection we present herewith an extract from a paper by A. J. Beaton, M.Inst.C.E., which appeared in the South African Railway Magazine. Mr. Beaton, in his paper, presents data secured from the United States, Great Britain and South Africa. The article is one which it will well repay those interested to read. We quote from Mr. Beaton's article as follows:

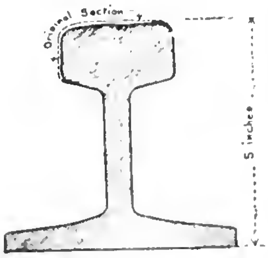
There is a considerable divergence of opinion among railway engineers, and many confused ideas exist, as to the average life of a steel rail. An expert authority has estimated that an 80lb. rail will be worn out after carrying about 250,000,000 tons of traffic. The railways of the world have a mileage of about 642,000 miles, and yet for strictly replacement purposes hardly two million tons of steel rails are used annually, although American rail mills are producing about four million tons of rails per annum, the bulk of these, however, being for new railway construction.

In New York State one rail breaks every year for each 3.8 miles of single track, or about one rail in every 1,220. The number of rail failures, covering 83 American railroads during the year 1910, according to the Committee on Rail, of the American Railway Engineering Society, ranged from 0 to 1,129 rails per 10,000 tons of new rail. On the continent of Europe one rail in from 1,350 to 2,000 breaks every year, while on the South African Railways for the year 1911, 301 rail breakages were reported, being about one rail in every 25 miles, or one rail failure in about every 8,600. The South African Railway figures do not embrace the rail failures in station yards and sidings.

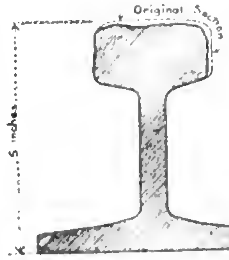
The bulk of the breakages in America were of the 85lb. and 90lb. section, and included several 90lb. titanium rails.

None of the breakages have been attributed to inherent weakness of the rails, the failures being alleged to unusual strains induced by such severe conditions "as the action of flat wheels, defective counterbalanced wheels, wheels out of round, defective track, poor ballast and improper track fastenings," while the recent increase in axle loads and high speeds have considerably reduced the time factor for the reversal of stresses under the wheel loads, thereby inflicting more punishment on the rail than what would have taken place under lighter axle loads and lower speeds.

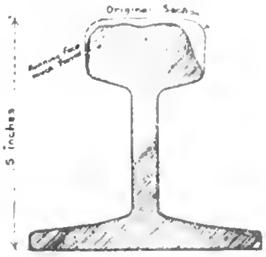
The rails on the American railways were of recent rolling, and the majority of the failures occurred during the three coldest months of the year, the month of Janu-



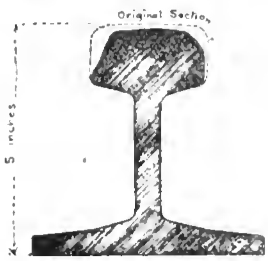
Nº 1.



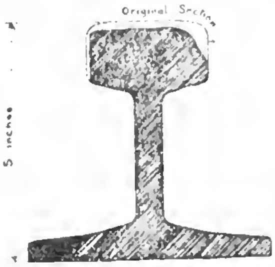
Nº 2.



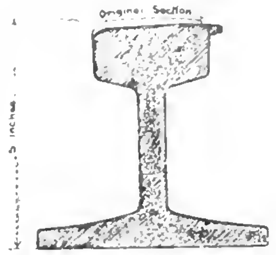
Nº 3.



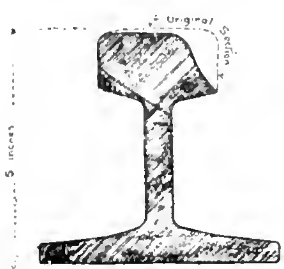
Nº 4



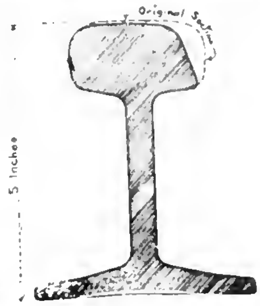
Nº 5.



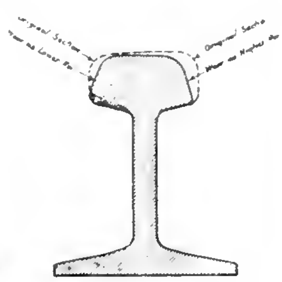
Nº 6.



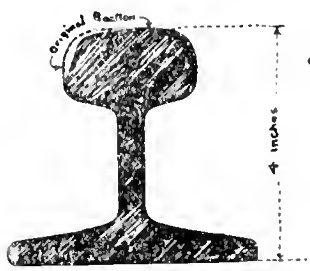
Nº 7.



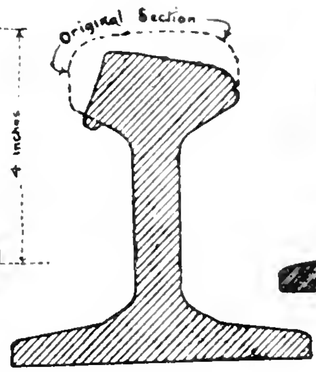
Nº 8



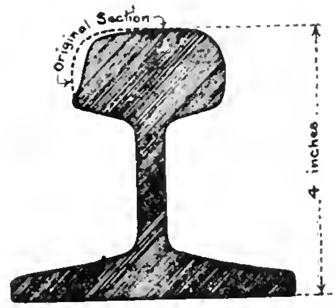
Nº 9.



Nº 10.



Nº 12.



Nº 11.

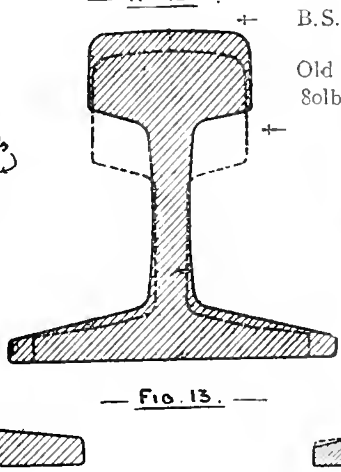
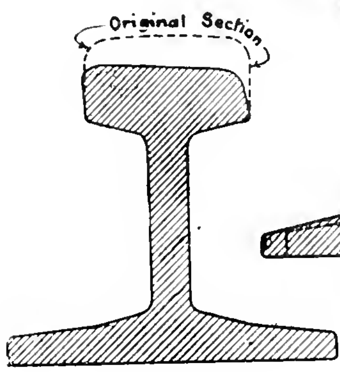


Fig. 13.



Nº 12ª.

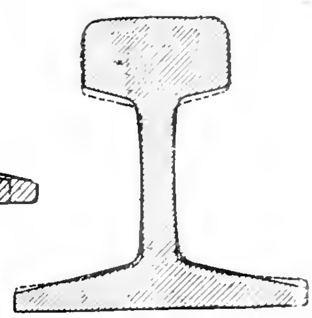


Fig. 14.

ary accounting for 1,645 breakages out of a total of 3,951 for the year. In June only 52 failures were reported. On the London and North-Western Railway, England, the number of rail failures in 1898 were twice as many during the winter months as in summer.

Life of Rails.—The life of a rail is greatly dependent on the nature of its composition, its geographical position, the type of rolling stock, the volume of traffic, and the quality of ballast.

An 80lb. rail, of 5-inch section, laid in a tunnel on the New York Central and Hudson River Railroad, carried 65,000,000 tons with a loss of ⅜-inch of metal upon the head before it was removed. The loss of metal on the top of rails on all sections of the tunnel was about twice as rapid as rails in the open subjected to the same tonnage.

On exposed sections of many railways running along the sea coast, corrosion due to the action of the sea-air is very severe on steel rails and fastenings.

The discovery of an effective anti-corrosive composition will be valuable and remunerative, both to the inventor and railway companies.

It has been recorded that an 80lb. rail was in service on the Great Northern Railway, England, for 35 years. The analysis of this rail indicated a very soft rail with high phosphorus.

On lines with slow and heavy traffic the head of the rail may have less ductility with slightly greater abrasion resistance than would be permissible for lines carrying a high speed passenger service. On the other hand, rails subjected to heavy traffic and high speeds should be of the very best composition, and improved in their wearing quality, even at an enhanced price, and every effort made to arrive at the best scientific disposition of the materials so as to synchronize the life of every section of the rail.

In discussing the wear of rails on curves, Mr. Beaton states that no comprehensive reliable information has hitherto been collected on any of the South African railways, although exceptional opportunities were presented in the way

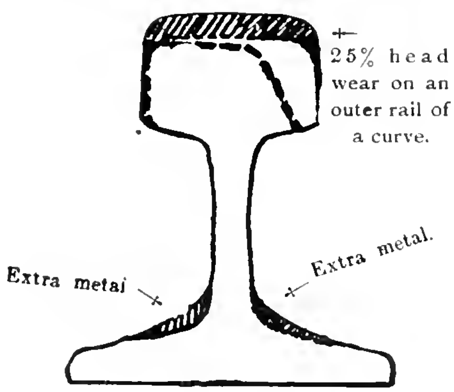


Fig. 15.

of an extraordinary abundance of sharp curvature, and consequently the scientific world has been deprived of much valuable data.

Table Showing Life in Months of 75lb. Rails, A.T.S.F.Ry.

Radii of Curves in Feet.	574	717	955	1146	1433	1910	Feet.
Outer rail . .	9	15	24	40	56	72	Months.
Inner rail . .	18	24	48	60	72	96	

Statistics are not compilations for satisfying curiosity, but should be of such practical commercial value as to enable future efforts to be directed into more successful channels, and to assist in correct deductions being arrived at. When the reliability of statistics is once assured they should

Life in Months of 100lb. Rails on P.R.Ry.

	ft.	ft.	ft.	ft.	ft.	ft.	Tan-
Radius	637	717	955	1433	2865	5760	gent.
Life in months . .	9	14	20	30	60	90	120

be accepted and acted upon, even if they upset one's pet theory, or clash with popular preconceived conclusions.

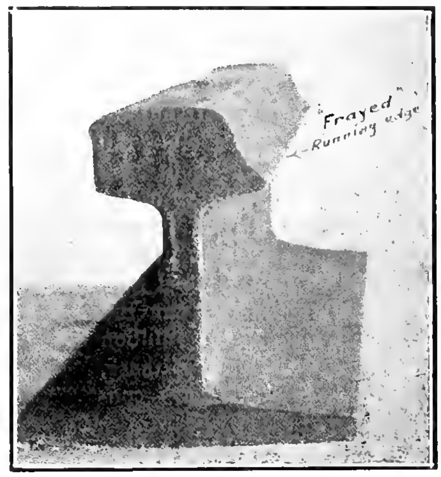


Fig. 16.

In Europe, where curvature is not so severe as in most other countries, although elaborate tests have been made in connection with determining the wear of rails due to errors in curvature, no very extensive experiments are recorded in regard to the excess wear on curves in relation to the wear on tangents.

American railways have, however, made some attempts to arrive at the relative life of rails on sharp curves and tangents. The Aitchison Topeka and Santa Fe Railway has tabulated the approximate times of removal of 75lb. rails on the sharp curves on the mountain section of their system, particulars of which are given in the above table.

Investigations made by the Pennsylvania Railway in this connection have not differentiated between the wear of the outer and inner rail, the table given above merely indicates the average wear on 100lb. rails on various radii, under heavy main life traffic.

This table corroborates the accepted axiom that the excess rail wear on a curve varies approximately as the degree of curvature

The conclusions arrived at from the experiments made on American railways are that the excess wear on a 574ft. curve will be about 230 per cent. of the rail wear on a tangent. Tests made on the Northern Pacific Railway indicate that the excess wear on a curve over that on a tangent, is a little less than one-quarter of the tangent wear per degree of the curve. It is, however, doubtful if these results will be applicable to the 3ft. 6in. gauge and the type and weight of rolling stock on the South African railways.

There are many important factors affecting the wear of rails on curves which might well claim the closer investigation of engineers on maintenance of way, and practical experience and minute inspection is the best school in which to acquire the requisite knowledge. It is a well-known fact that errors of over 8 per cent. from the true curvature re-

duces the life of a rail from one-third to one-half its natural life, had the curvature been true. Similarly, irregularity in gauge or in super-elevation have a disturbing influence on the wear of rails and on the smooth riding of the track.

The writer observed on a 12 degree (478ft. radius) curve,

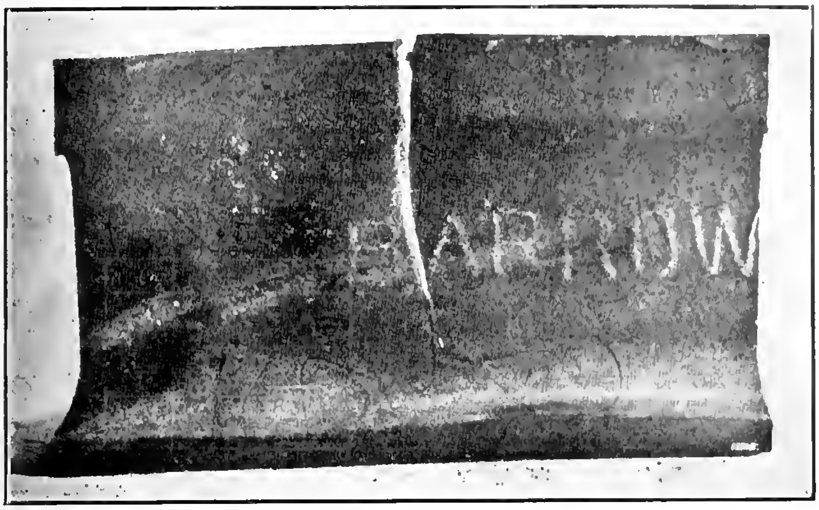


Fig. 18.

with 4 inches of super-elevation and a gauge width of 3ft. $6\frac{5}{8}$in. on an up-grade of 1 in 50 compensated, that the abrasion on the lower rail of the curve was very severe, but no side wear was apparent on the higher rail, while on a 140 deg. (410ft.) curve, with a similar super-elevation and grade, but with only a gauge width of 3ft. $6\frac{1}{2}$in., the wear on the running edge of the higher rail was very marked. On another portion of this curve, where the gauge was widened to 3ft. 7in., no side wear of either rail was observable. This points to the necessity for allowing liberal "slack to gauge" on very sharp curves, rather than increasing the super-elevation, as is sometimes practised.

On a single track railway there is the insuperable difficulty of securing the correct super-elevation for both directions of traffic, thus on a 1 in 50 down grade, on a 10-chain curve with 4 inches of super-elevation, a speed of thirty miles per hour is permissible with passenger rolling stock, but anything approaching this speed cannot be attained by an up grade passenger train, while heavy goods traffic barely reaches ten miles per hour, hence for such slow speeds only half an inch super-elevation would be required; it, therefore, becomes necessary to approximate the super-elevation to about the mean speed of the up and down trains, for if the full theoretical super-elevation demanded for the maximum permissible speed on sharp curves is adopted on a steep down grade, then undue wheel flange pressure will be exerted on the lower rail by upgrade slow trains. It would, therefore, appear as if the maximum permissible safe speed cannot be permitted on sharp curves with steep gradients.

It was the practice on the Central South African Railways to remove side-worn rails from the higher side of curves and replace them in the lower side of the curve, while in many instances, when the versed sine of a rail was not over 3 inches at the centre the rail was reversed in its original side of the curve; generally after the side wear on the head of the rail indicated a loss of from three to four pounds, the rail being finally removed from passenger lines after losing about 10 per cent. of its original weight. The average services of 60lb. rails on 150 metre curves ranged between three and four years. Unfortunately, no record was kept of the rolling tons of traffic which passed over the track.

A similar practice obtained on the Rhodesian Railways, although in Natal, owing to the rapid wear of rails on 300ft. curves and 1 in 33 grades, the practice of exchanging the rails was not adopted, but in some cases side worn rails were laid on tangents, a practice which does not give so satisfactory results as when reversed in their original position or transferred to the opposite rail in the curve.

On the Cape Government Railways curve worn rails were not exchanged, as was the custom on the other administrations.

Sections of worn rails recently removed from curves on the South African Railways are seen in Figs. 10, 11, 12 and 12a.

The table given will serve to better appreciate the value of the above sections of rails.

On some American railways 90lb. rails are removed from the main line after showing a head wear of 25 per cent. A safe practice is to remove all worn rails from passenger service lines when they show a loss on their original weight of 8 per cent. on curves and 10 per cent. on tangents, dependent, however, on certain factors of speed and traffic obtaining on particular sections. Professor Webb describes some interesting tests conducted on the Northern Pacific Railroad, regarding the wear of rails on curves. The figures obtained indicated that the rail wear is comparatively small during the first half of the life of a rail, and that the rate of wear grows in geometric ratio, especially so on sharp curves. This may possibly be due to the wear of the rail conforming to the outline of the wheel tyres, causing an acceleration of the abrasion on the running face of the rail through the close contact of the knuckle of the tyre

The average yearly loss in weight in lbs. of five rails on the outer side of a 10 degree curve (578 ft.) on the Northern Pacific Railway, extending over a period of five years, showed the following results:—

	1st year.	2nd year.	3rd year.	4th year.	5th year.
Loss in lbs. ...	10.85	9.55	7.75	11.65	16.55

The tests were made over a variety of kinds of steel, each rail having lost a little over 8 per cent. on their weight, and are described as "badly worn," yet not actually removed from the track.

Remarks.—Nos. 1 and 2 are still in the track, having done 54 months' service to date.

Nos. 3, 4 and 5 were in the track for 47 months, on higher side of curve, then turned end for end in their original side of the curve, and finally removed from the track after 17 months' service on their new running face, after a total service of 64 months.

Nos. 6 and 7 were removed from service at the end of the above periods.

Nos. 10 and 11 represent the wear on rail after a period of 215 months, but were left in the track until 1912, a total service of 240 months, but no record was kept showing the wear after final removal from the track.

Figs. 16 and 17 represent the photographs of a section of an 80lb. rail from the Boven Deviation. This rail is from a 410 ft. radius curve 1 in 70 grade. It did service in the high side of the curve for 35 months, and was then changed over to the low side, and finally removed from the track after being 17 months in the low side of the curve owing to

the excessive "fraying" of the new running edge, so clearly shown on the photographs.

A number of rails by various makers, and collected from different railways in England, showed very little deterioration or wear on the top of the rail. After a service of an average of sixteen years, and having carried an average of 100,000,000 tons, the head wear only showed a little over ¼-inch on average.—(Vide Proceedings Inst. C.E., Vol. CXXXVI.).

Fig. 21.

Forty-five per cent. of the rails on the London and North-Western Railway broke after carrying between 25,000,000 and 50,000,000 tons of traffic, while only 17 per cent. failed after carrying between 50,000,000 and 100,000,000 tons.

It is, however, very difficult to say what internal deterioration takes place in rails from "fatigue" of the metal, or what brittleness is developed by the cold hammering of the wheels; therefore, loss of weight or severe abrasion of surface cannot alone determine the limits of the usefulness of a rail. On the other hand, the Colonial maintenance engineer has not the necessary apparatus at hand to accurately determine the various factors affecting the durability of a steel rail; he must, therefore, for the present, at any rate, fix the limit of its usefulness by its loss of weight or other visible physical defects which renders it unsafe for use in the track.

In connection with the excessive wear of rails on curves, more attention might be devoted to this important matter, and it would well repay maintenance engineers to give the subject closer scrutiny and more scientific study, with the view of elucidating the relative life of a rail and its resistance to wear in varying degree of curvature, gauge, and super-elevation, as any accurate data obtained in this connection would undoubtedly form a valuable asset to track economics.

Improved Rail Section.—The first thought suggesting a remedy for excessive rail head wear is to increase the area of the metal subjected to the greatest wear, and such a proposal has been submitted for discussion by Mr. W. S. Potter, of the Manganese Steel Rail Company, New York, whose suggestion consisted of the addition of more available head metal and increasing the thickness of the base by the addition of fillets between the web and base.

The section shown in white outline, is an American 90lb. rail, the shaded areas indicate the proposed additional section which adds 15lbs to the weight of the rail, while the heavy dotted line on the head of the rail represents a loss of 25 per cent of metal on the head of a worn outer curve rail.

As side-wear on curves is much in excess of on straights, Mr. Potter's suggestion is not quite practicable, as it involves a redundance of head metal on tangents, or else necessitates having different depths of rails on curves and tangents, with the attendant objectionable joggled junction fishplates.

The additional area in the fillets of the web of Mr. Potter's rail also appear somewhat excessive, as the bulk of failures in the web originate where slots are provided in the base of the rail for spikes—presumably to stop creep—cutting notches for spikes in the edges of the flanges of a rail is not good practice, knowing how sensitive steel is to any detrimental form, of which the angular shape is the most aggravating.

1	2	3	4	5	6	7	8	9	10
Reference to Sections Illustrated	Name of Railway.	Radius of curve and (cant).	Grade compensated.	Type of Rail.	Original weight of Rail	Loss of weight per lineal yard.	Which leg of curve removed from.	Gross Rolling load passed over rail.	Length of service
No.		Feet (ins.)			lbs.	lbs.		In 10,000 tons.	months
1	"Boven Deviation" Eastern Line	478' (4")	1 in 66	B.S.S.	80	2¼	Higher	880	52
2		478	1 in 66	„	80	3¼	Lower	880	52
3	Transvaal.	410		„	80	6¼	Higher	800	47
	Ditto	(4½")	1 in 70				Higher	280	17
4	Ditto	410'	1 in 70	„	80	6½	Higher	800	47
	Ditto	(4½")					Higher	280	17
5	Ditto	410'	1 in 70	„	80	6	Higher	800	47
	Ditto	(4½")					Higher	280	17
6	Natal Main Line ..	300' (5")	1 in 30	„	80	4½	Lower	900	10½
7	Ditto	300' (5")	1 in 30	„	80	7½	Higher	640	7½
8	Eastern Line Transvaal	500' (4")	1 in 50	Z.A.S.M.	60	4¼	Higher	—	36 to
9	(Low Velt)	500' (4")	1 in 50	„	60	6½	Higher & Lower	—	48
10	O.F.S. Main Line ..	495' (3¾")	1 in 80	C.G.R.	60	3	Higher	Not ascertainable.	240
11	Donker's Poort ..	495' (3¾")	1 in 80	„	60	3	Higher		240
12	Natal Main Line ..	500 (5")	1 in 39	N.G.R.	78	12¼	Higher Lower	„	120 22
12a		300 (5")	1 in 33	N.G.R. B.S.S.	80	12¼	Lower	„	12

South African Railways.
Table Showing Details of Grade, Wear, etc., on Sections of Worn Steel Rails.

The suggestion of increasing the area of the fillets to a small extent between the web and the base, is, however, worth further investigation, as many rails fail at these points before other sections are exhausted.

Fig. 13 shows the present prevailing 80lb. standard steel rail of American railways, with the old section of the American steel 80lb. rail super-imposed thereon in dotted lines. Fig. 14 shows the B.S.S. 80lb. rail super-imposed in dotted lines on the existing standard 80lb. rail of the American Railway Engineers' Association.

The American Railway Engineering Association has observed "a difference between rails of different mills when the sections and chemical compositions are practically the same," and has consequently deputed steel experts to determine by actual tests which of the leading steel manufacturers turn out the best rails.

The figures 18 and 21 are reproductions of photographs taken of a worn-out 78lb. rail from the Natal Main Line. Mr. Chas. G. Bateman, Assistant Superintendent of Maintenance, quotes the life history of this rail as follows:—"It was laid on straight about 1898. Removed from straight and put in high side of 500 feet radius curve at 42¼ miles, on the 6th December, 1908; taken out from high side of this curve on 2nd November, 1910, and was relaid again on the 9th of the same month for relaying low side of 300 feet radius curve at 40½ miles, 'Satan's Hole,' and broke under combined train on the 5th August, 1912, when it was scrapped. Grade 1 in 30, and trains usually negotiate this grade

fairly steadily. Loss of weight, 13 lbs. 5 ozs. per yard." This represents a loss of about 17 per cent. which is somewhat in excess of the recommended maximum.

It will, therefore, be seen how important it is to give a close and observant study to everything affecting the wear on rails, in order to effect every economy possible in connection with a unit which is far and away the most expensive constituent part of the permanent way.

Even from these meagre notes it must appear manifestly clear that a wide field of research is open to the railway engineer in connection with the problem of the steel rail, and any careful investigations of a practical or scientific nature will be welcomed as an effort to assist in solving a hitherto neglected factor which reflects so materially on the economical functions of railway engineering.

GOVERNMENT HEARING ON THE GRAND RIVER CONTROL.

On Wednesday, April 16th, at 10 a.m., a delegation received a hearing from the Ontario Government on the question of the control of the Grand River. The Government was represented by Hon. Dr. Reaume, Minister of Public Works; Hon. Mr. Duff, Minister of Agriculture; and Messrs. Pattinson, M.P.P., Mills, M.P.P., and Richardson, M.P.P.

The delegation was a large one, representatives from all the municipalities along the river, from Dunnville to Fergus, being present.

Mr. J. P. Jaffray, of Galt, the President of the Grand River Improvement Association, in presenting his argument for Government action, said that the Grand River valley ran through one of the most thickly populated sections of the province, and also one of the most important in manufacturing, agriculture, and general interests in the Dominion. He added that delegations had been approaching the Government during the past twelve years. The flood menace was constantly increasing, while the low-water flow was dwindling.

Mr. T. H. Jones, City Engineer of Brantford, spoke of the work done on the river by the Hydro-Electric Power Commission last year, and of their recommendation that this work should be continued on a more thorough scale so as to get all data and designs required. He added that the Commission should be requested to fully report on the project. He spoke of the large expense incurred by the city of Brantford (over $100,000), and flood protection was still far from satisfactory.

Mr. Kerr, of Fergus, spoke of the desirability of a Government reservation of large size on the waste land, or nearly so, of the head water areas of the Grand River.

Mr. W. H. Breithaupt presented his reasons for believing the Government should take action, and his argument is given at some length in this account, as it gives some valuable data on the Grand River.

The Hon. Dr. Reaume stated that he was strongly impressed with the urgency of the case, and would recommend Government action. He suggested that municipalities along the river should contribute a part of the funds required to carry on the investigation.

The following data on the Grand River was presented by Mr. W. H. Breithaupt, M. Inst. C.E., in the course of his address:—

Drainage area of the Grand River, 2,600 square miles, essentially the central part of the peninsula of south-western Ontario; parts of the counties of Grey, Dufferin, Perth, Oxford, Norfolk, Halton, Wentworth and Haldimand and the whole of Wellington, Waterloo and Brant. The drainage area is wide, and of largest expanse along the upper part of the river. The Conestogo branch rises also on the head plateau almost as far north as the main river.

Total fall of the river from the head plateau of its rise to its outlet into Lake Erie is over 1,100 feet.

The head water plateau was originally large swamp, probably to the extent of 400 square miles in area or more. During the last fifteen or twenty years especially this swamp area has been cleared and drained. Run-off from it is now very rapid at times of snow melting and heavy rainfall, whereas formerly it was slow and snow melting was greatly retarded. In consequence spring floods of the river have greatly increased.

Tributaries of the main river in their order from up-stream are the Conestogo from the west, the Eramosa-Speed from the east, and the Nith from the west.

Precipitation, rainfall and snowfall are not definitely known in the watershed of the Grand River. There are but few observing stations. From other stations and from partial records it appears likely that the total precipitation, rainfall and snowfall in the upper part of the watershed is 35 to 40 in. or more, whereas on the lower part, which is also narrower, the annual precipitation is somewhat less. There are no data on run-off, but it is safe to estimate that for the head-water area it amounts to 12 in. or more per annum.

There are various methods of flood control of a river. Deepening of the channel and the construction of dykes along the banks allows a large increase in the volume of the water passing. Another method is to raise the general level of the banks which are to be kept above water. All such methods are palliative only and benefit the immediate locality only. A much better method is to remove the cause of floods by impounding near the sources. It is apparent that this method is not applicable to all rivers. Certain topographical conditions are essential to its success, as also definite general conditions of the drainage area. Impounding must be at locations where a large part of the flow of the entire river can be arrested, and for a reservoir the valley must contain an extended basin with high enough banks and a reasonably narrow neck, again with high banks, for the construction of a dam.

The only possible method by which uniformity of flow or an approach to such uniformity, can be secured, is by storing surplus waters in seasons of flood and releasing them in seasons of drought. It may be stated that as a general rule a sufficient amount of storage can be artificially created in the valley of any stream to rob its floods of their destructive character, but it is equally true that the benefits to be gained will not ordinarily justify the cost.

The determining factors in the control of the flow of a river by storage are:—

(1) The flood flow of the river.

(2) The amount of sustained flow, for low-water period, that can be provided for. And further:—

(3) The cost, including the value of the area flooded as compared with the benefits to be derived.

(4) The situation of the storage basin: whether it can be placed so as to have enough contributory drainage area and at the same time properly control a sufficient length of the river to make it worth while.

(5) The character of the water to be impounded, whether it is clear or so charged with sediment that silting will unduly shorten the life of the works.

From general indications it appears that the Grand River is peculiarly well adapted for storage control, and that the required works can be carried out at a cost to make them well worth while. Before definite conclusions can be drawn, however, it is necessary that much more detailed and extensive examinations should be made.

Observation extending over many years confirms that all larger floods come primarily from the head-water area and extend the length of the river, as naturally occurs by reason of the wider expanse of this area and the greater precipitation there It is evident, therefore, that control of the yield of the head-water area will enable prevention of the destructive crest of the flood throughout the length of the river, as also reasonable maintenance of sustained flow for the whole river. Land condemnation for reservoir sites will be comparatively moderate in cost. The drainage area of the main river to the outlet of the Conestogo branch is approximately 460 square miles, while that of the Conestogo branch is approximately 330 square miles. A storage basin of sufficient size located on the main river a short distance above the outlet of the Conestogo, another smaller one on the main river above Fergus, also a considerable storage basin on the Conestogo branch as near its outlet as may be—these three basins with a total dischargeable capacity of, say, 2,500,000,000 to 3,000,000,000 cubic feet, would, it is estimated, suffice to catch the destructive part of any flood, and would have enough contributory drainage area to give a sustained flow of 400 to 500 cubic feet per second below the outlet of the Conestogo branch. Storage also on the Eramosa-Speed and on the Nith tributaries could not only materially better this result for the main river below their respective outlets, but give required flood protection to the large population centres, especially on the Speed, as well.

The definite data to be obtained are:—

Extended records of rainfall and snowfall at various points throughout the drainage area, and particularly on the head-water area.

Continuous stream-gauging at a sufficient number of points in the main river and branches to determine the run-off factor, as also rapidity of run-off.

Full topographical survey of possible storage basins and examination by test borings of dam site for each basin.

Delimitation of the upper river drainage area and of the head-water areas of the branches.

BRICK PAVEMENT SPECIFICATIONS.

The American Society of Municipal Improvement has published standard specifications for brick pavements as adopted by the society at its last annual convention. An interesting paragraph of the specifications is that the brick shall not lose of their weight more than 22 per cent. when submitted to the rattler test.

Samples of brick of uniform shape and appearance are required to be taken from each car (estimated at 10,000 brick). Brick having defects that would cull them shall not be used. Three grades of samples shall be tested—one of the softest, one of the medium and one of the hardest burned. If all of the tests overrun 22 per cent. loss, the car shall be rejected. If one or two of the tests overrun, another test of said grade or grades shall be made. Should only one of these tests overrun 22 per cent. loss, the contractor may cull said grade, provided they do not exceed 10 per cent. of the amount of the brick in the car, and deliver the balance on the improvement. Otherwise the whole car will be rejected. In order to prevent the continued shipments of inferior brick, only two cars of two separate shipments of any make of any brick will be tested. Should they fail to meet the requirements stated above, said make of brick will be rejected for this improvement.

Among the cities which permit no more than 22 per cent. loss by abrasion are Baltimore, Grand Rapids, Akron, Toledo, Newark, Philadelphia, etc. Only 21 per cent. loss is allowed by Chicago, Indianapolis, Canton and Columbus.

MODERN INDUSTRIAL LIGHTING SYSTEMS.

That the Tungsten lamp has already become the permanent standard illuminant for mills and manufacturing establishments is the opinion of Albert L. Pearson, electrical engineer, of Lockwood Greene & Co., as presented in a recent paper read before the American Society of Mechanical Engineers at the Boston Engineers' Club. The following remarks are taken from this paper:—

For certain work in which line distinction or clearness in combination with wide diffusion is the prime requisite, the mercury arc is a close competitor. One principal objection to the mercury arc, however, is the entire lack of red light waves in its spectrum. A fluorescent reflector, which will supply to a certain extent these missing red rays, makes the light more natural and at the same time less objectionable. On the other hand, the Tungsten lamp gives a nearly white light, approaching the ideal sunlight. Its high efficiency and ready adaptation to varying intensities also partly account for its adoption as a standard lighting unit.

In addition to providing a suitable form of lamp, a great deal of attention and careful study is now given to the proper arrangement of the lighting system itself. Lamps should be arranged to give uniform illumination at the working plane, avoiding shadows as far as possible, and paying particular attention to the requirements of each machine and each operation. White walls and ceilings are advantageous, and add to the effectiveness of any lighting arrangement. With modern individual drive it is possible to keep the rooms clearer of belts and shafting than with the mechanical or group drive, thus benefiting the lighting system. On account of glare, low, exposed units should, of course, be avoided wherever possible, and in places where lamps hung low down are necessary, reflectors which will entirely conceal the filaments should be used. In such cases a few lamps well placed close to the ceiling will overcome the effect of light and darkness.

The position of lamps should be carefully determined, both as to spacing and mounting height. Mr. Pearson believes that each problem must be considered by itself. He says that no general rule can be given, even for plants doing the same work, as changes in layout will greatly affect any system of illumination, but that in general the height of the lamp above the floor should be such that, with the spacing available, the lines representing the angles of maximum illumination with a given type of reflector will cross at the working plane.

The amount of light and the arrangement of lamps depends also upon the nature of the work and the character of the machines. Good lighting should provide safety for employees, better sanitary conditions, and, in many cases, better quality of work and increase in productivity. The best lighting should be provided for the most particular processes. In places where good light is not required, or where it is used for a comparatively short time, obviously it is not necessary to invest as much for this part of the equipment as in places where light is required for longer periods or is depended upon for quality in the work.

The day of working out a lighting system arbitrarily as so many watts per square foot of floor space or so many foot candles is passed. A study must be made of the conditions and a layout designed which will prove both economical and give the best illumnation. The distributing systems also should be designed to secure as good voltage regulation as possible and circuits arranged to eliminate waste of power for lighting any sections not in use.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

The Elements of Chemical Engineering. By J. Grossman, M.A., Ph.D., F.I.C., with preface by Sir William Ramsay, K.C.B., F.R.S. Cloth; second edition; 50 illustrations. Price, $1 net. Charles Griffin & Company, London, Eng.

Reviewed by J. Watson Bain, B.A.Sc.*

It is a matter of common remark that the superintendents of many of our factories are being drawn from the ranks of university graduates, and this is particularly true in the chemical industries. After a more or less lengthy apprenticeship in the laboratory and in the factory, the man with a good technical training and a sufficiency of common sense usually develops into a valuable official, and the rapidity with which this end is attained depends very largely upon the rate at which a familiarity with routine operations and apparatus is acquired. In the school or university the instruments employed are small and easily handled, while the use of glass and porcelain overcomes the difficulty of dealing with corrosive liquids. The college graduate then, on entering the manufacturing field, finds himself confronted by new problems which arise in the handling of large quantities of material, and it is here that valuable time is often lost in the endeavor to cope with changed conditions. To the chemist who finds himself in such circumstances or to the student who has not yet graduated, Dr. J. Grossman's "Elements of Chemical Engineering" will be of great assistance. Dr. Grossman has set himself to bridge the gap between the laboratory and the factory, and has produced a short treatise, which deals with the subject in a clear and interesting manner. The comparison of the simple forms of laboratory apparatus with their factory equivalents is emphasized in a novel fashion and assists materially in acquiring ideas as to the construction and uses of the latter. The author draws attention continually to the differences between an operation as carried out on a small scale in the laboratory and as executed on a large scale in the factory; such emphasis deserves particular commendation in view of the not infrequent blunders which arise from a lack of appreciation of this important distinction.

The chapter on technical research is particularly valuable to the young students and will suggest to him that manufacturing materials are not pure, that the solubilities of his ingredients are important and that careful experiment must be carried out in the devising of a factory process. The actual design cannot be treated in a volume of this size, and the student is referred to the more extended literature dealing with this phase. The fact that there is no other short treatise in English which covers the same field will make this book a welcome addition to the library of the young chemical engineer.

The illustrations are numerous and well chosen, while the author advises his readers to make a collection of catalogues and price lists.

* Associate Professor of Applied Chemistry at the University of Toronto.

Electrical Machine Design. By Alexander M. Gray, B.Sc., Assistant Professor of Electrical Engineering, McGill University, Montreal. Publishers, McGraw-Hill Book Company, 239 West 39th Street, New York. Cloth; 500 pages, with illustrations and charts. Price, $4 net.

Reviewed by J. A. Johnson.*

In the preface to this work the author states: "The study and design is of the utmost importance to all students, because only by such a study can a knowledge of the limitations of machines be acquired." A statement of this sort is very apt to be made by specialists who happen to hold professional positions. Each one seeming to believe that his own particular subject is the one really essential one. If they all were allowed to have their way students would have to devote their lives to preparing for their life work. It certainly is arguable, that engineers would do better to have a knowledge of the limitations of machines; that, in fact, the progress in design comes from the demands of those big-minded men who know nothing about the limitations of machines, but do know what they want and keep after it till somebody finds out that the so-called limitations are no limitations after all.

The book is of approximately 500 pages divided into four sections and forty-nine chapters. The four sections are respectively of direct current machinery, alternator and synchronous, polyphase, and induction motors and transformers. The method followed is, as to each section: First, the consideration of the theory of operation followed by a description of the types and forms of construction; consideration of characteristics of performance, procedure in design and typical specifications; the latter would stand considerable improvement, especially as to form. Mechanical design is not gone into except incidentally. One chapter only is devoted to the consideration of a few of the fundamental mechanical problems.

The author states that the work was compiled as a course of lectures. Its value as a text-book would seem to be confined pretty largely to the use of special students of design, as it seems rather too voluminous to find a place in the regular course for all students, except at the expense of time that

* Electrical Engineer, Ontario Power Company, Niagara Falls, Ont.

would be more profitably spent otherwise if broad-gauge, open-minded engineers rather than specialists are the object of the trade.

Building Construction and Drawing. (Elementary Course.) By Charles F. Mitchell, Lecturer on Building Construction to Regent Polytechnic, London, Eng.; Head Master of the Polytechnical School, assisted by Geo. A. Mitchell, A.R.I.B.A. Cloth; 472 pages; 7 x 4½ inches; about 1,100 illustrations; eighth edition; by D. VanNostrand & Company. Price, $1.50 net.

The book aims to give with conciseness and accuracy a statement of the principles which should govern the execution and building work. The authors wish it to be equally valuable as a guide for students engaged in building. The contents comprise of fourteen chapters including Instruction to Beginners, Brickwork, Masonry, Girders, Joints in Carpentry; Floors, Partitions, Wood Roofs, Composite Roofs, Iron and Steel Roofs; Joinery Plumbing, Slating and Tiling, Building Quantities, and Memoranda. A few exercises are included in each chapter, and the appendix contains an index and treats with the Examination Papers and Syllabus of the English Board of Education. It contains the subject matter of previous editions carefully revised and subjects not hitherto treated or emphasized are: Isometric Projection, Monolithic Brickwork, Bonding of Brick Footings, Hollow or Storm Walls, Facing Bond, Fixing Bricks, Example of Face Jointing in Masonry, Polishing of Marbles, Calculations of strengths of Timber Pillars, Expansion Joints for Girders and Trusses, Quotations from the L.C.C. General Powers Act, 1909, Prevention of Dry Rot, Relative Position of Members in a Typical Roof, Ferro-Concrete for Roof Construction, Description of Door Hinges, and the New Rules (1910) for the Admeasurement of Slating and Tiling.

The present issue is the eighty-seventh thousandth which speaks for itself as to its usefulness and appreciation by those interested in building construction.

Building Construction.—A text book on the principles and details of modern construction for the use of students and practical men (advanced and honor courses). By Charles F. Mitchell, Lecturer of Building Construction to Regent Polytechnic, London, Eng., Head Master of the Polytechnical School, assisted by Geo. A. Mitchell, A.R.I.B.A. Seventh edition revised and much enlarged; 885 pages; 800 illustrations; cloth. Price, $2.50 net.

The authors state that since the publication of the sixth edition considerable advances have been made in knowledge of building materials and methods of construction, thereby rendering it necessary to again revise and amplify and bring their book into line with current practice. Calculations have been rechecked; fresh examples added, and the text revised, and neither labor stinted nor counsel disregarded to make the new edition deserving of the approbation bestowed upon the former issues.

It contains 28 chapters. The chapter subjects are: Limes and Cements; Concrete; Asphalt; Plastering; Stones; Bricks; Tiles; Terracotta and Stoneware; Iron and Steel; Timber; Paints and Varnishes; Glass; Foundations; Brickwork; Flues; Fire-places and Tall Chimneys; Masonry; Carpentry; Half-timbered Work; Pillars; Columns and Stanchions; Graphic Statics; Girders; Fire-resisting Construction; Reinforced or Ferro-Concrete; Joinery; Stairs and Hand Rails; Sanitation Water Supply; Hot Water Apparatus and Ventilation; Electric Bells and Lighting.

The effects of the London County Council regulations in connection with skeleton framed buildings, and of those proposed to be adopted by the council with regard to buildings of reinforced concrete, have entailed the complete re-writing of the chapters dealing with these subjects, and as these regulations may serve as models of their kind it has been thought desirable to give their text in full.

Due note has also been taken of the revised report of the Royal Institute of British Architects on Reinforced Concrete, as well as of the recommendations of the District Surveyors' Association and of the recent work of the Engineering Standards Committee.

Throughout the book, the endeavor has been to describe the essential principles of good construction and to illustrate them by typical examples selected as far as possible from actual practice.

No further comment is needed on the merits of this book than the fact that with the present issue it will have reached a circulation of 52,000.

A Handbook of English for Engineers. By Wilbur Owen Sypherd, Professor of English in Delaware College. Flexible leather cover; 314 pages; 4 x 7 inches; Scott, Foresman & Company, Chicago and New York. Price, $1.50 net.

The author's aim and hope that the contents of this book should be "of practical assistance to engineers in college classes and the early years of professional life" should most certainly be fulfilled. He has apparently, in preparing the book, carefully read the available literature on the subject and been painstaking in partly compiling and selecting from same. The book should be very useful in higher engineering classes and will doubtless find a place on the shelves of many engineers.

The book contains five chapters, dealing respectively with General Problems of Engineering Writing, Mechanical Details Common to the Various Forms of Technical Writing, Business Letters, Reports, and Articles for Technical Journals.

The first chapter touches on the problems of technical writing. In the second chapter directions for the use of abbreviations, punctuation marks, capital letters, etc. To engineers desirous of strengthening their English these two chapters are likely to be most serviceable.

The third chapter, on business letters, briefly states the main principles governing successful business correspondence and supplies examples of good and bad usage. There is, however, no mention of methods of drawing special emphasis to points under consideration.

The fourth chapter contains a systematic treatment re rhetoric of engineering reports. The author discusses the general essentials of reports; then gives more fully the requirements of reports on tests, reports on inspection work, and periodical reports, with examples of each kind.

The fifth chapter deals with articles for technical journals. He divides his subject into short articles and longer articles, including under the former editorials, summaries and abstracts, book review and explanations of new inventions.

It is a book dealing with a subject important to every engineer, and which in the first efforts to become technically proficient is often sadly neglected by them. Many an engineer, capably equipped technically, is sadly handicapped for advancement in his profession by neglect of just such niceties of rhetoric as this book brings out. It would be well for those who have not given much thought to this subject to possess themselves of the book.

PUBLICATIONS RECEIVED.

Bureau of Railway Economics. Bulletin No. 45. 30 pages. Address, Washington, D.C.

Municipal Bulletin. Issued by the Ohio State Board of Health, Columbus, Ohio. Vol. 3, No. 2.

Municipal Bulletin. Issued by the Ohio State Board of Health, Columbus, Ohio. Vol. 3, No. 3.

Illuminating Engineer. Special gas centenary number. Address, 32 Victoria Street, London, S.W.

Canal Statistics for 1912. 111 pages; issued by the Department of Railways and Canals, Ottawa, Ont.

Manitoba Engineer. Published by the Engineering Society of the University of Manitoba. 80 pages.

Resources of Tennessee. April issue. Published by the State Geological Survey. Address, Nashville, Tenn.

Metallurgie. Journal published by the Society of Engineers and Industries, 20 rue Turgot, Paris, France.

Commissioner of Works' Report. Seventh report. 27 pages. Address, Department of Works Office, Toronto.

Report of Commissioner of Public Roads, State of New Jersey, year ending 1912. Cloth; 6 x 9 inches; 160 pages; illustrated

University of Wisconsin. Bulletin of summer session. 105 pages. Issued by University of Wisconsin, Matheson, Wisconsin.

American Society of Mechanical Engineers. Journal of the Society for April, 1913. Address, 29 West 39th Street, New York City.

American Institute of Electrical Engineers. Proceedings of the Society, April, 1913. Address, 33 West 39th Street, New York City.

American Society of Civil Engineers. March issue of the Proceedings of the Society. 620 pages. Apply 220 West 57th Street, New York City.

Irrigation. (Part of Part VI.). Annual report of the Department of the Interior for year 1912, together with maps. 123 pages. Address, Ottawa.

Farm Forester, by E. J. Zavitz, Professor of Forestry (Bulletin No. 209): 30 pages; issued by the Department of Agriculture, Toronto, Ontario.

American Waterworks Association. Proceedings of the 32nd Annual Convention. Apply to the Secretary, J. M. Divin, 47 State Street, Troy, N.Y.

Department of Mines. Annual report for Province of Nova Scotia, 1912. Prepared by the Commissioner of Public Works and Mines, Halifax, N.S.

Oil and Gas Wells Through Workable Coal Beds. Bulletin No. 65. By G. S. Rice and O. P. Hood. Issued by the Bureau of Mines, Washington, D.C.

Summary of Commerce and Finance of the United States for February, 1913. Issued by the Bureau of Farm and Domestic Commerce, Washington, D.C.

Conference Rulings of the Interstate Commerce Commission. Bulletin No. 6; cancels and includes Bulletin No. 5. Issued April 1, 1913, at Washington, D.C.

Review and Expenses of Steam Roads in the United States for December, 1912. Bulletin No. 49; issued by Inspector Commerce Commission, Washington, D.C.

Geographic Board of Canada. Eleventh report for year ending June, 1912. A supplement to the annual report of the Department of Marine and Fisheries, Ottawa. 240 pages.

Ignition of Mine Gases by Filaments of Incandescent Lamps. Bulletin 52. By H. H. Clark and L. Ilsley. Issued by Department of Interior, Bureau of Mines, Washington, D.C.

Patents. Illustrated official journal of patents for Great Britain, April 2, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C Price 6d.

Patents. Illustrated official journal of patents for Great Britain, March 19, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C. Price, 6d.

Apparatus for the Exact Analysis of Flue Gas. Technical paper No. 31. By G. A. Burrell and F. M Siebert. Issued by the Department of the Interior, Bureau of Mines, Wasbington, D.C.

Report of Board of Commissioners, Water and Lighting Department of the City of Harrisburg, Pa. Twenty-fifth annual report, for 1912. Apply, Commissioners' Office, Harrisburg, Pa.

Metal Mine Accidents in the United States for the Year 1911.—Technical Paper Number 40; 54 pages; compiled by A. H. Fay, Department of the Interior of the Bureau of Mines, Ottawa, Ont.

International Geological Congress. Second circular, Canadian edition of the programme of the coming meeting of the International Geological Congress, in Canada, summer of 1913. 45 pages. Apply to the secretary, Victoria Memorial Museum, Ottawa, Ont.

CATALOGUES RECEIVED.

Corrugated Pipe Company.—Thirty-page catalogue, 8 x 5 inches. Address, Stratford, Ont.

American Locomotive Company.—Bulletin No. 1,012. Mikado type locomotive built for Chesapeake and Ohio Railway.

Concrete in Farming Improvements.—Sixteen-page pamphlet, published by the Canada Cement Company, Montreal, Quebec.

Castings.—A reference for buyers of foundry equipment and supplies; Vol. 12, No. 1. Published by the Gardner Printing Company, Caxton Building, Cleveland, Ohio.

Chicago Giant Rock Drill, Tappet Type.—Bulletin No. 137. 16 pages; illustrated. Published by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Chicago Giant Rock Drill, Mountings.—Bulletin No. 138. 10 pages; illustrated. Published by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Chicago Giant Rock Drill, Appurtenances.—Bulletin No. 139. 16 pages; illustrated. Published by the Chicaga Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Dolarway Pavements.—Well illustrated catalogue, 9 x 6 inches; 34 pages. Important to everyone interested in pavements. Apply, Dolarway Paving Company, Whitehall Building, New York City.

Universal Bulletins.—Published by Uuiversal Portland Cement Company. 10 pages; illustrated. Apply, Publicity Bureau of Universal Portland Cement Company, 72 West Adam Street, Chicago, Ill.

The Labor Saver.—Publication issued monthly by Green Publishing Company in the interests of the mechanical handling of material for Stephens-Adamson Manufacturing Company. Address, Aurora, Ill.

High-Grade Engineering Instruments.—Illustrated pamphlet, 8 x 5 inches; 72 pages. A very complete list with instructions as to adjustments. Published by the Hanna Manufacturing Company, Troy, N.Y.

Jeffrey Swing Hammer Pulverizer. Bulletin No. 31 L. A typical and practical machine for reducing ground limestone for agricultural purposes. Size, 9 x 6 inches; illustrated. Issued by the Jeffrey Manufacturing Company, Columbus, Ohio.

Co-operative Information Bureau, of Boston.—Bulletin No. 4, giving aims and officers of this society, organized in 1912; a voluntary association of persons and organizations for mutual assistance in the ascertainment of sources and places of information.

The Ransome Concrete Machinery Company, Dunellen, N.J., have issued a well-illustrated 80-page general catalogue covering the entire Ransome line, which includes every piece of equipment necessary in a complete concrete plant. This catalogue will be sent to anyone interested upon request. Write the nearest office of the company for a copy of the "Red Book."

A new standard price list on "Sterling" new code rubber-covered wire has been issued by the Standard Underground Cable Company, of Canada, Limited, Hamilton, Ont. The price list is in convenient and durable booklet form, printed in two colors, and gives prices on their "Sterling" wire for bases ranging from 13 to 20 cents for solid and stranded wire of all commercial sizes. Appended are explanatory notes and a list of electric wire cables and cable accessories manufactured by this company. The price list will be sent on request to the company.

Bitumen Cable and Mining Accessories.—The British Insulated and Helsby Cables, Limited, of Prescot, Lancashire, England, of whom the Canadian British Insulated Company, Limited, of Montreal, are the sole Canadian representatives, have forwarded a copy of their catalogue on bitumen cables and mining accessories. The catalogue is a most handsome one typographically, and the illustrations show very clearly the different types of cables and the many wiring accessories incidental to mining work manufactured by the company. Copies of the catalogue may be secured by addressing the Canadian British Insulated Company, Montreal.

The Engineering Works of Canada, Limited, Montreal, send us a copy of their catalogue "G," which is devoted to alternating current generators. The catalogue contains a very carefully prepared and illustrated description of the construction of these generators and will no doubt be read with a great deal of interest by electrical engineers all over Canada. These generators are built under the patents of the "Société Alsacienne de Constructions Mecaniques." The pamphlet contains 20 6 x 9 pages, and is very fully illustrated, and any reader interested may obtain a copy by addressing the Engineering Works of Canada, Limited, New Birks Building, Montreal, Que.

Strauss Direct Lift Bridge is the title of a very attractively gotten-up bulletin which we have received from the Strauss Bascule Bridge Company, of Chicago. It contains a very interesting illustrated description of the Strauss direct lift bridge which involves an application of the counterbalancing mechanism of the Strauss bascule to the vertical lift bridge. The pamphlet, which contains 22 pages, is illustrated by means of a colored half-tone and several line drawings, and no doubt bridge engineers will be interested in seeing this pamphlet, copies of which, we understand, can be secured by addressing the Strauss Bascule Bridge Company, 104 South Michigan Avenue, Chicago, Illinois.

Refined Asphalt for Municipal Paving Plants is the title of a very interesting 22-page pamphlet which we have received from the American Asphaltum & Rubber Company, of Chicago. The pamphlet contains a good deal of information concerning the qualities of asphalt as a paving material. City engineers, roadway engineers and paving contractors would do well to secure a copy, which can be done by addressing the American Asphaltum and Rubber Company, 600 Harvester Building, Chicago, Ill.; the Canadian Mineral Rubber Company, Canadian Express Building, Montreal, Que., or the Canadian Mineral Rubber Company, 503 Canada Building, Winnipeg, Man.

The Lagonda Reseating Machine.—Bulletin G 1. Illustrated pamphlet, 6 x 9 inches; describing construction and use of the Lagonda Manufacturing Company's portable carborundum wheel for removing soot and scale from the faces of caps and tube ends on boilers. These wheels are driven by either electric, water, steam or air motors and the photographs showing actual cleaning operations greatly assist in understanding the value of this reseating machine for making a steam and water-tight joint when replacing the caps on B. & W. and similar boilers after having been removed for tube cleaning purposes. Copies may be had by addressing the company at Springfield, Ohio.

Peebles Alternating Motors, Polyphase Induction Type.—Pamphlet No. 16 B. 25 pages; 8 x 10 inches. Eight different types of standard machines dealt with on pages 6 and 7 of the pamphlet. The company are always prepared to design machines to meet special conditions. A very full specification of the motors is given in the pamphlet, together with illustrations of various parts and of some of the different types of motor referred to above. In addition, outline illustrations and full lists of approximate weights and dimensions of every size which they manufacture are given, while full lists of technical data for 50 and 25-cycle motors are also given, machines being dealt with for three separate ranges of voltage from 110 up to 3,500 volts, at speeds of from 1,500 down to 150 r.p.m. Issued by Bruce Peebles & Company, Limited, Edinburgh, Scotland.

Messrs. Gent & Company, of Leicester, England, send us their catalogues Nos. 4, 5 and 6. Catalogue No. 4 is devoted to a description of their Tell-Tale clocks, designed for checking the movements of watchmen in warehouses, factories, mills, etc. Catalogue No. 5 is devoted to a description of their silent electric impulse clocks and electric turret clocks, which are suitable for public buildings of all kinds, such as fire halls, municipal buildings, railroad stations, etc. Catalogue No. 6 is devoted to their water level indicators and alarms, the object of these being to indicate and record inch by inch the variations in depth of water in distant reservoirs, wells, rivers, docks, etc. The Canadian representatives of Messrs. Gent & Company are Messrs. E. A. Mansfield & Company, P.O. Box 223, Hamilton, Ont.

Catalogue of book "Essentials of Electricals of Electricity." Text book for wiremen on electrical trades. By W. H. Timble. 271 pages; 224 figures; cloth. Price, $1.25 net. Publishers, John Wiley & Sons, New York.

Catalogue of book "Steam Engineering." By William R. King. 450 pages; 177 figures; cloth. Price, $4 net. Publishers, John Wiley & Sons, New York.

Messrs. Vickers, Limited, have been commissioned to build a Parseval airship for the Admiralty, the builders to pay royalties to the German company on every ship they build. The Admiralty are naturally anxious that all aircraft for the navy shall be built in Britain, and after the arrival of the first Parseval the remainder will be built in England.

COAST TO COAST.

Vancouver, B.C.—An engineering party of the Pacific Great Eastern Railway under the direction of S. A. Dice, has completed the final location between the Second Narrows through North Vancouver to Point Atkinson lighthouse, and is now engaged on similar work between the lighthouse and Newport at the head of Howe Sound. This is regarded as evidence of the intention of P. Welsh, the contractor, to undertake construction on the lower section without further delay. It has now been definitely established that the maximum grades between those two points will not exceed one per cent. The route will follow the shore line virtually all the way and will only be a few feet above high-water mark. Instead of winding past the Point Atkinson lighthouse the railway will cut through a natural draw east of the lighthouse, then strike Howe Sound and follow it all the way to Newport. The project of bridging several of the indentations along the coast has been abandoned and the road instead will be through a number of tunnels, one of them to be about 820 feet long, thus making several advantageous cutoffs. The construction from the lighthouse to Newport will be exceedingly heavy, as the cost of considerable of the milage, it is estimated, will be at least $100,000 a mile. The location of the line between Lillooet and the vicinity of Fort George, a distance of 290 miles, is now in progress. The work now being undertaken is on the lower section of the route north of Lillooet, actual construction on which is to be undertaken this summer. Eleven hundred men are now employed in the various camps along the route from Lillooet south along Seaton and Anderson Lakes and beyond to Pemberton Portage.

Ottawa, Ont.—Chief Engineer Bowden of the Railways and Canals Department, and Engineer Weller, who is in charge of the work on the Welland Canal, have returned from a trip to Panama, where they spent the past month studying and investigating the latest engineering developments as exemplified on the Panama Canal, with a view to applying the ideas to the new Welland undertaking. The government is anxious for the Welland to be the latest word in modern canal construction. The two engineers are starting work at once on designing the canal construction, and tenders will be called for as soon as possible. The preliminary work is already well under way, the route having been decided upon and the first surveys being also about complete. It is almost impossible for the contractors to get more than a start this year, but the next five years will see great activity along the line of the "big ditch" across the Niagara peninsula. The canal that is being planned is designed to meet future needs for a long period, and will be one of the greatest works of its kind on the continent.

Niagara Falls, Ont.—Regulation by the state of the amount of water which may be diverted from the Niagara River above the Falls on the American side for power purposes will be provided for in a bill introduced by Majority Leader Wagner, of the United States Senate. The measure, which embodied the recommendations of Attorney-General Carmody, recently submitted to the legislature by the governor in a special message, is designed to repeal practically all outstanding grants for diversion for power purposes and to limit diversions to the Niagara Falls Power Company and the Hydraulic Power Company.. If the measure becomes law, future diversions by these two companies will be restricted to 8,600 and 6,500 cubic feet per second respectively. These are the same restrictions which were contained in the Burton Act, which expired in March last. Provision will be made that the remainder, 4,400 cubic feet per second, not utilized under the Burton law, remain under the jurisdiction of the conservation commission. The bill would vest in the conservation commission authority over measurements of waters diverted and would provide severe penalties for violation.

PERSONAL.

MR. GEO. SMITH, engineer of Lindsay, Ont., has been appointed town engineer of Midland, Ont.

MR. MERVIN D. HALLMAN, of Berlin, has been appointed county road superintendent for the county of Waterloo.

MR. H. J. BOWMAN, M.Can.Soc.C.E., and partner of the firm of Bowman & Connor, consulting engineers, of Toronto and Berlin, has been appointed engineer of the county of Waterloo., Ont.

MR. E. G. AITKEN, chief geographer of the Lands Department of British Columbia, has been elected a Fellow of the Royal Geographical Society of London. Mr. Aitken, who came to the provincial service from the Geological Survey Branch at Ottawa, has had long experience in the United States and also at the Edinburgh Geographic Institute.

STEWART McPHIE, of Hamilton, Ont., has formed a partnership including B. Frank Kelly and E. H. Darling as consulting engineers. Mr. McPhie was for several years connected with the Hamilton Bridge Company. Mr. Darling is a mechanical engineer, graduate of Toronto University, and an associate member of the Canadian Society of Civil Engineers. Mr. Kelly is a member of the Ontario Association of Architects.

MR. R. A. ROSS, acting manager of the Toronto Hydro-Electric System, has made the following appointments on the Hydro staff: Percy E. Hart, as electrical engineer; J. Orr, general superintendent; George Stevenson, general inspector; Geo. Schwanger, as engineer of distribution; J. M. McNeilly, superintendent of meter department; R. J. Lee, contract agent; J. B. Kitchen, engineer of operation department, and G. Devlin, as head salesman.

MR. H. H. COUZENS, general manager and electrical engineer of the corporation of Hampstead, London, Eng., has been appointed general manager of the Toronto Hydro-Electric System. Mr. Couzens has had a wide experience in the practical work of designing and carrying out of the construction work involved in the complete installation of electrical plants, having held important positions on an ascending scale with the corporations of Taunton, Bristol, West Ham, and Hampstead. He will assume his duties in a few weeks.

A. R. KETTERSON, A.M.Can.Soc.C.E., and Associate of the Royal Technical College. Glasgow, Scotland, has been appointed assistant engineer under J. G. Sullivan of the Canadian Pacific Railway, looking after bridge works, western lines. Mr. Ketterson has been in the employ of the Canadian Pacific Railway about seven years. He commenced as field inspector on bridge work in Quebec, Ontario, Alberta and British Columbia. His next step up was the appointment as bridge draughtsman in the office of the engineer of bridges, Montreal, and his third rise was to the position of engineer, designing bridges in the same office. Mr. Ketterson left that position to come to Winnipeg.

The following engineers have been assigned to fixed districts in regards to the hydrographic work of the British Columbia government: F. W. Knewstubb, who surveyed the upper Columbia River watershed; E. Davis, who reported on the watershed of the Kootenay, west of the Selkirks, and the Slocan River watersheds; Clifford Varcoe, who mapped the

Kettle River and Arrow Lakes watersheds; O. F. D. Norrington, who surveyed the Okanagan watershed; W. R. C. Morris, who also reported on the Okanagan; J. F. Rowlands, who reported on the Nicola River watershed; W. R. Pilsworth, who surveyed the Thompson and Bonaparte Rivers.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO SECTION).

The sixth regular meeting of the Toronto section of the American Institute of Electrical Engineers will be held at the Engineers' Club, 96 King Street West, at 8 p.m., on Friday evening, April 25th, 1913.

Mr. E. E. F. Creighton, of the General Electric Company, Schenectady, N.Y., will address the meeting on "Electrical Protection." This address will deal with electrical disturbances and will be illustrated with numerous photographs and experiments. H. T. Case, secretary, 709 Continental Life Building, Toronto.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Sixth regular meeting will be held at the Engineers' Club, 96 King Street W., April 25th, 1913. Secretary, H. T. Case, 709 Continental Life Building, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa: Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa: Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, May 1, 1913 Contents of this issue on page 659

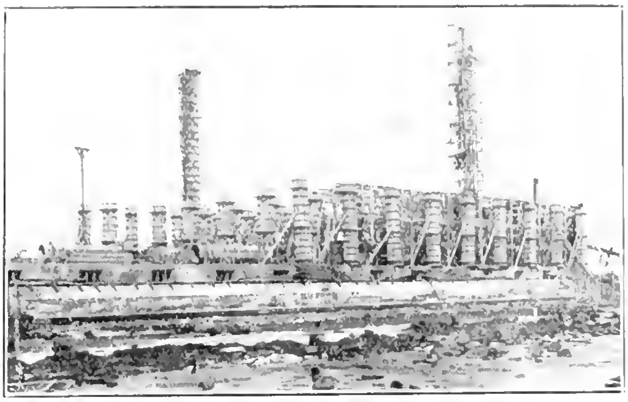
The Canadian Engineer

An Engineering Weekly

DOCK DESIGN AND CONSTRUCTION IN FORT WILLIAM AND PORT ARTHUR

By WM. C. SAMPLE.*

With an ideal location, associated with many other natural advantages, Fort William and Port Arthur, popularly known as the "Twin Cities," are destined to become one of the greatest inland ports of the American continent. Fort William and Port Arthur are separate townships, with their own municipal governments, but for all practical purposes may be considered as one port. Fort William's harbor consists chiefly of river frontage. The Kaministiquia River, popularly and for self-evident reasons, known as the "Kam," together with its offshoots, the McKellar and Mission Rivers, is the means of providing Fort William with 26 miles of land-locked harbor, with the addition of two islands by way of good measure. The natural channels of these rivers have been dredged to a depth of 30 feet; the "Kam" widened to 600 feet; the McKellar to 400 feet, and the Mission to 500 feet.



Showing Dock Wall, Taken from the Harbor.

A turning basin upwards of 1,000 feet in width is about to be made 6½ miles from the mouth of the "Kam" and this will necessitate the removal of upwards of twenty-three acres of solid earth.

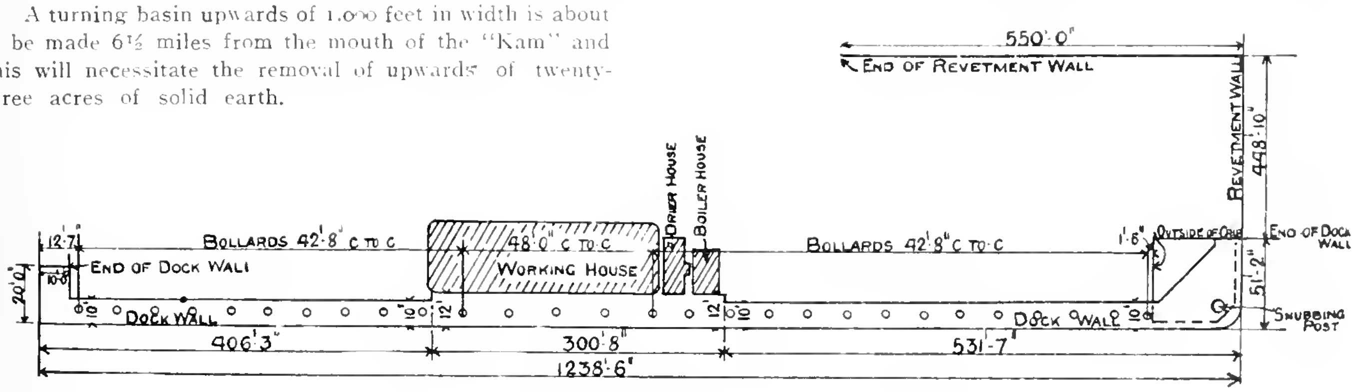


Fig. 1.—Twin City Dock Construction—Layout Plan.

Port Arthur, to whom Nature has not been quite so lavish in her gifts of water frontage, has, nevertheless, a harbor of which she is justly proud, and, furthermore, is the lucky possessor of a fine up-to-date ship-building plant (the western dry dock) where upwards of 900 men are employed, and from which many of the finest lake steamers have been turned out.

Those of my readers who may be interested in the Twin Cities harbor development might, with advantage, communicate with W. R. J. Burdett, the genial and energetic labor commissioner of Fort William, who will be pleased to supply them, as he has supplied me, with all available information.

As will be noted, Nature has provided the Twin Cities with the necessary water frontage, and it remains for the Dominion and civic authorities to take full advantage of the unique opportunities offered them of making the cities into the greatest of all lake ports. Much has been done in this direction, but more remains to be done. It behoves the responsible authorities to map out some approved system of planning and laying out their docks, and to see that all such work actually carried out is of a stable and permanent character. There is a decided tendency in these days to think only of present needs, and not of future requirements, and it is to be hoped that the authorities will avoid this error, and bear in mind that future generations will judge their work. There should be little fear of the result, however. The public men of Fort William and Port Arthur, backed up by the Dominion Government, are determined that their port will become a

*Mr. Sample is now a Consulting Engineer in practice at Fort William. Prior to coming to Fort William he occupied important Municipal Engineering positions with the Sunderland, Bootle (Liverpool) and Sheffield Corporations, and for five years acted as Designer and Estimator to the Brooklyn Grade Crossing Commission who are carrying out improvements aggregating $10,000,000 in value. He is a Charter Member of the American Society of Engineering Contractors.

port of which they will have just reason to be proud, and with this feeling paramount, their efforts are bound to prove successful.

The greater part of the dockage in the Twin Cities port is provided by the different elevator companies, who have provided excellent facilities for the speedy loading of grain-carrying steamers. The government elevator at Port Arthur, now in course of erection by the Barnett McQueen Company, for whom E. D. Casseday is chief engineer, is a notable example of this, and it is the purpose of this article to deal with the elevator dock now under construction, and of which the writer of this article was the designer.

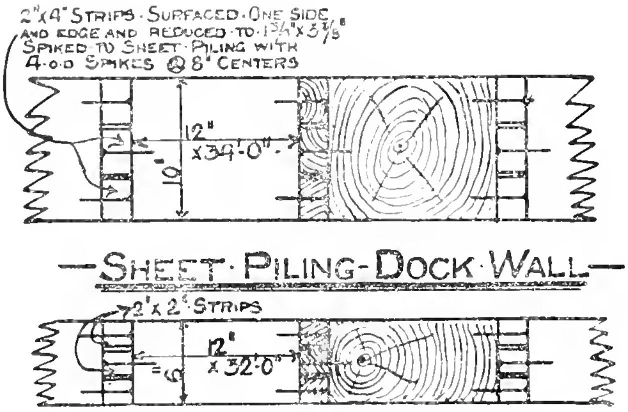


Fig. 2.—Sheet Piling Revetment Wall.

Fig. 1 shows the layout of the dock, which consists of concrete dock walls of 10 and 12 feet widths, and revetment walls of the lengths shown on the layout plan. It would, perhaps, be advisable to consider these different type walls separately, and this we will proceed to do.

Concrete Dock Walls.—A double row of piling was first driven with the centre line of the outer row, 2 feet 8 inches in from the outside of the face line of the concrete dock face, the piles being spaced 5 feet 4 inches centre to centre in both directions, and afterwards cut off at elevation 600.0, the level of mean low-water, Thunder Bay, on which the dock wall abuts. To the outside of the outer line of piles a 10-inch by 12-inch fir wale streak was bolted, the top of the wale streak being flush with the cut-off elevation of the piles. The bolting was accomplished by means of 1-inch diameter by 27-inch machine bolts at each pile-bearing. Outside of this wale streak sheet piling 10 inches by 12 inches by 34 feet was driven, every second pile being bolted to the wale streak with a ⅝-inch diameter by 24-inch machine bolt. To the sheet piling, and with the top level with the top of the sheet piling, wale streak and piles, a 12-inch by 25-pound channel iron was bolted by means of ¾-inch diameter by 27-inch machine bolts at 3 feet on centres.

The sheet piling was jetted and tapped into position, and sharpened at the bottom ends in order to ensure close driving, and form a perfectly sand-tight bulkhead. The sheet piling was furthermore tongued and grooved by building on to the edges 1¾-inch by 3⅜-inch strips of timber, obtained by surfacing one side and edge of 2-inch by 4-inch strips. The strips were spiked to the 10-inch by 12-inch sheet piling with 4 o.d. wire spikes spaced at 8 inches on centres. This construction is illustrated in Fig. 2.

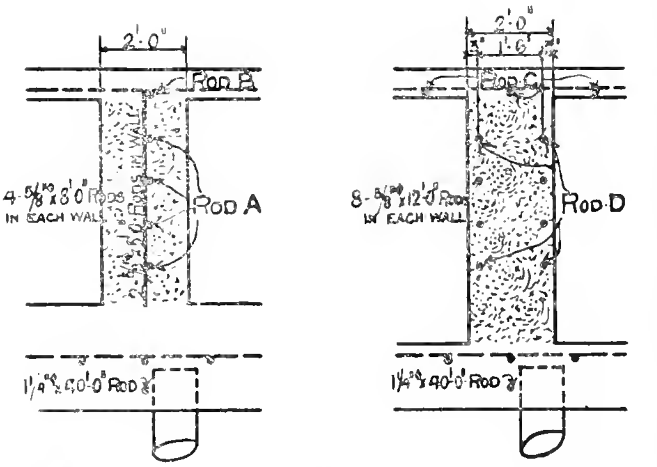
The 12-inch by 25-pound channel iron, to which reference has already been made, was punched to receive the ¾-inch diameter by 27-inch machine bolts, and also for 1¼-inch diameter anchor rods, spaced 5 feet 4 inches on centres. These anchor rods were attached to the channel by means of heavy nuts, and had a length of 40 feet with a 12-inch thread at each end. The anchor rods were passed through an anchor log, held in position by means of spur piles, and attached to same by heavy nuts and washers.

A second line of anchor rods, 1¼-inch diameter by 58 feet, placed 10 feet 8 inches on centres, connected the previously mentioned anchor log, and a second anchor log held in position by the outer row of piles, forming a trestle required in connection with the general elevator construction. These anchor rods were furnished, as in the case of the 40-foot anchor rods, with heavy nuts and washers. Spur piles were cut off at elevation 602.0.

At the outer corner of the dock wall a timber crib 48 feet by 48 feet, divided into 16 compartments by means of tie walls, was placed. The crib was built of 12-inch by 12-inch timbers, the outer walls solid and the inner walls half open. The timbers in the outer walls were halved at the corners, thus forming perfectly strong joints, whilst the inside timbers, instead of resting one upon the other, as in the outer walls, were placed to cross one another at the junction points. Fig. 8 shows the method of construction. After being built, the crib, which, it should be noted, was 23 feet in depth, was sunk to a depth of 24 feet below mean low-water datum, the elevation of the top of the crib thus being 599.0. The exterior walls were made sand-tight by having 1-inch by 6-inch battens nailed along the joints, on the inside of the walls, whilst the crib at the outer corner was cut off at an angle of 45 degrees. After the crib was sunk in place, it was filled with sand and gravel to the top, or elevation 599.0.

With the piling, sheet piling, channel and crib in position the next stage in construction was the building of the reinforced concrete dock wall.

The dock wall, as previously stated, is built in 10 and 12-foot cross sectional widths. Starting at the inshore end, adjoining a 20-foot return end, the 10-foot section is carried for a length of 406 feet 3 inches. At this point the width of the wall is increased to 12 feet, in order to join up with the



Section C C Fig. 9. Section F F

building line of the working house, which is 12 feet from the face of the dock wall. This 12-foot section continues along the frontage of the working house, drier house and boiler house, for a distance of 300 feet 8 inches. From this point the 10-foot section is carried to the crib, where, at the outshore end, it is increased to a solid mass of concrete with a face radius of 33 feet. The plans and sections clearly show the methods of construction pursued. The inshore end at the return corner was similarly strengthened by a solid block of concrete, less in bulk, naturally, than was required for the outshore corner of dock wall.

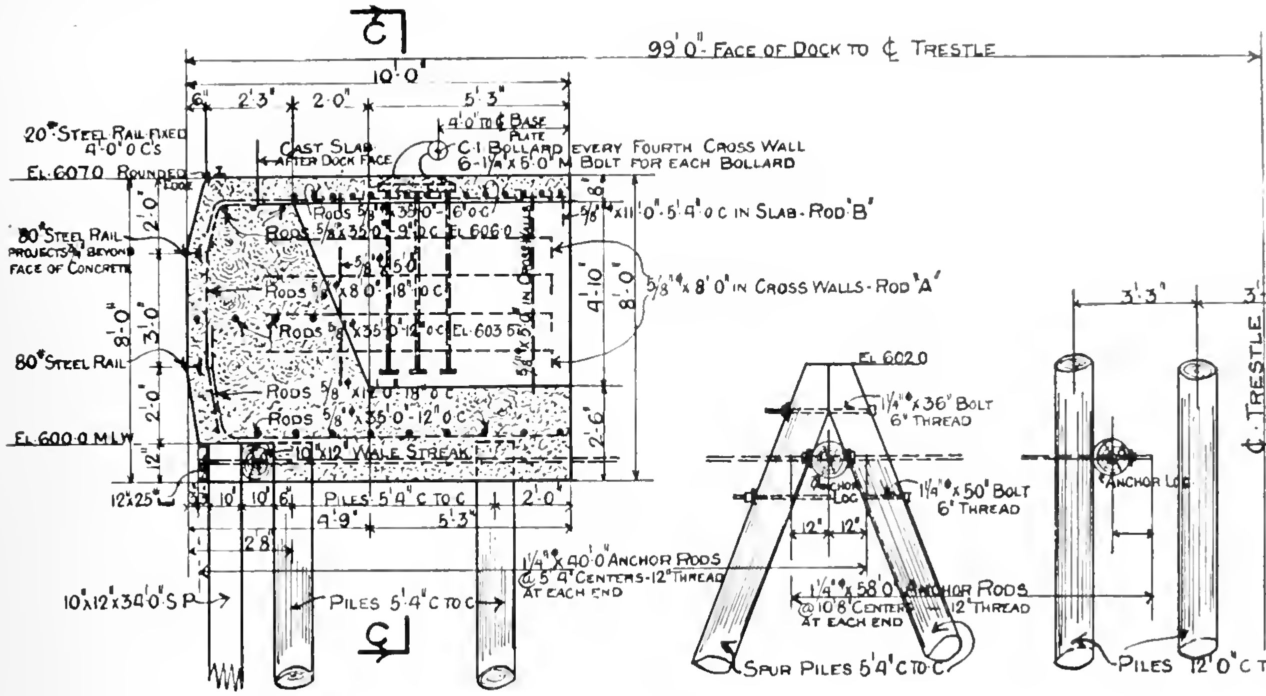


Fig. 4.—Section A A.

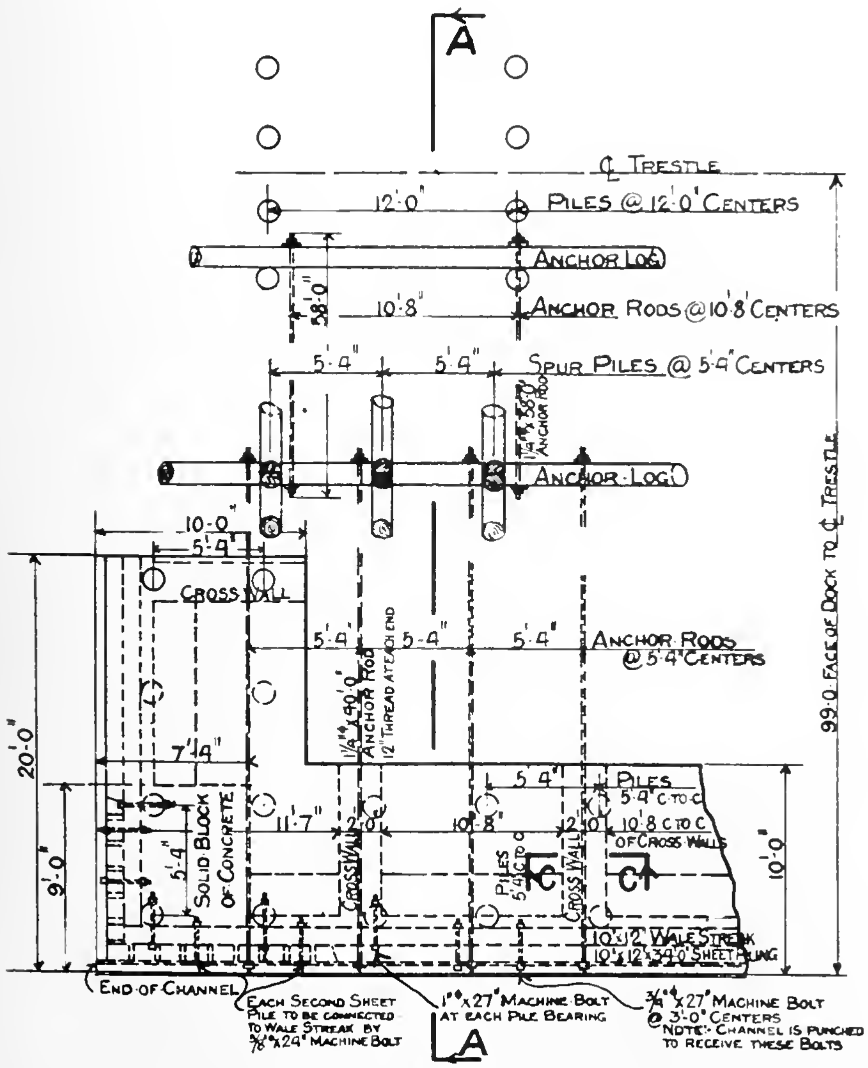
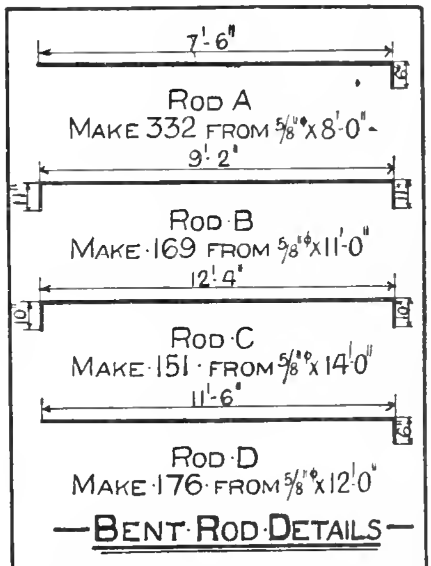


Fig. 3.—Plan at Inshore End.



Reinforcement List

No. of Rods	Size	Length
226	5/8"-Straight	5'-0"
1550	" "	8'-0" Includes 332 Bent Rods A
714	" "	12'-0"
160	" "	16'-0"
50	" "	22'-0"
12	" "	28'-0"
15	" "	30'-0"
1211	" "	35'-0"
169-B	" Bent	11'-0"
151-C	" "	14'0
176-D	" "	12'-0"

Fig. 11.

The piling at the outer corner of the dock was driven, as shown in details, whilst the anchor logs, spur piles, etc., previously described, were necessary only where the 10-foot cross sectional lengths of wall were built. The 12-foot cross sectional length of wall did not call for anchor rods, spur piles, etc., the necessary anchorage being obtained by substituting 1¼-inch diameter by 16-foot anchor rods for the 1¼-inch diameter by 40-foot anchor rods used in the 10-foot section and carrying same through into the mattress of the elevator buildings, the mattress in turn being carried forward under the 12-foot section of dock wall, thus forming the bottom slab or foundation of same.

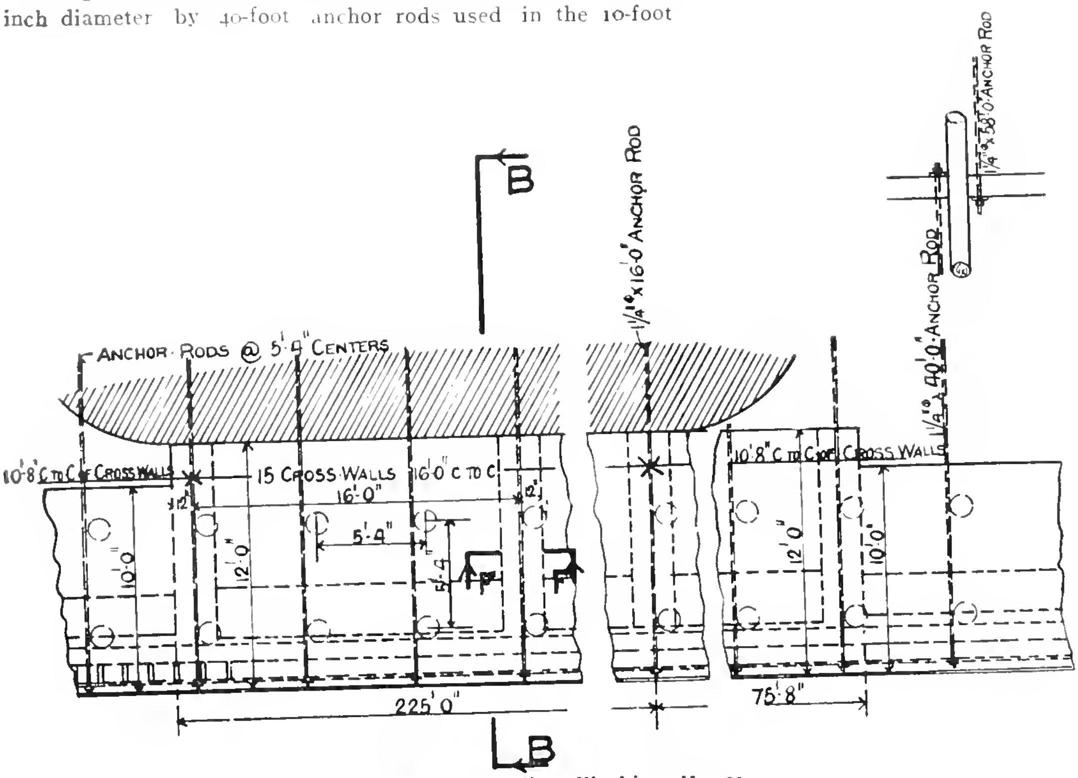


Fig. 5.—Plan Fronting Working House.

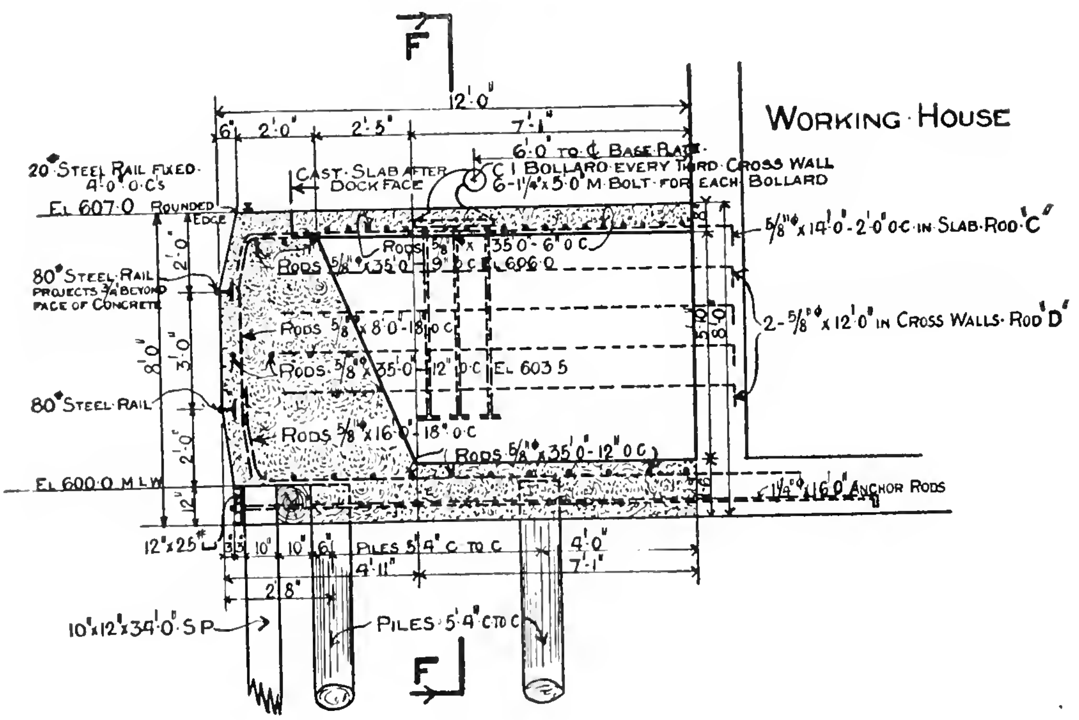


Fig. 6.—Section B B.

The sketches showing the cross sections of dock walls clearly illustrates their design and construction. The 10-foot cross section has a depth of 8 feet with an 8-inch top slab, 2-foot 6-inch bottom slab, and a connecting retaining wall of the dimensions shown. The face projects 6 inches beyond the back line of the channel iron and breaks back 6 inches at the top, the corner being rounded off. The bottom of the concrete starts at elevation 599.0, thus enclosing piles, wale streak, and anchor rods, and is finished off at the top at elevation 607.0.

Cross walls connecting the top and bottom slabs and 2 feet in thickness are cast with the dock wall, the distance from centre to centre of cross walls being 10 feet 8 inches.

The 12-foot cross section of the dock wall is similar to the 10-foot section as regards face formation and thickness of top slab. The connecting retaining wall is slightly varied, as the sketches will show, whilst the bottom slab, as previously stated, is formed by the continuation of the mattress of the elevator buildings, and is 1 foot 6 inches in depth.

The cross walls, or rather that portion of them fronting the working house, a length of 224 feet, are spaced at 16 feet centres, built on a continuation of the centre lines of working house columns. The remaining cross walls in the 12-foot section, whilst similar in construction, are built on 10-foot 8-inch centres, as in the case of the 10-foot section cross walls.

With regard to longitudinal reinforcement, the 10-foot section calls for 15⅝-inch diameter by 35-foot rods 6 inches on centres in the top slab, 3⅝-inch diameter by 35-foot rods 9 inches on centres, and 4⅝-inch diameter by 35-foot rods 12 inches on centres in the retaining wall section, and 9⅝-inch diameter by 35-foot rods 12 inches on centres in the bottom slab.

The cross sectional reinforcement consists of ⅝-inch diameter by 8-foot rods 18 inches on centres adjoining face

of dock, and ⅝-inch diameter by 12-foot rods on similar centres, running from near the face of the dock through the bottom slab.

The 10-foot section cross walls are reinforced as follows: Four cross rods ⅝-inch diameter by 8 feet, denoted rods "A," and two ⅝-inch diameter by 5-foot vertical rods. An additional cross rod ⅝-inch diameter by 11 feet denoted rod "B," and spaced 5 feet 4 inches on centres is used in the top slab reinforcement. Rods "A" and "B" are bent as shown on details, Fig 11.

Turning to the 12-foot cross sectional wall, we find the reinforcement somewhat different. The longitudinal reinforcement consists of nineteen ⅝-inch diameter by 35-foot rods, 6 inches on centres in the top slab, three ⅝-inch diameter by 35-foot rods 9 inches on centres and four ⅝-inch diameter by 35-foot rods 12 inches on centres in the retaining wall section, and eleven ⅝-inch diameter by 35-foot rods 12 inches on centres in the bottom slab.

The cross sectional reinforcement consists of ⅝-inch diameter by 8-foot rods, 18 inches on centres adjoining face of dock, and ⅝-inch diameter by 16-foot rods on similar centres, running from near face of dock through the bottom slab into the working house mattress. The top slab is further reinforced with ⅝-inch diameter by 14-foot cross rods 2 feet on centres. These rods are denoted rods "C."

The cross walls are reinforced with two lines of rods consisting each of four ⅝-inch diameter by 12-foot rods, denoted rods "D." Rods "C" and "D" are bent as detailed and listed in Fig. 11.

C.I. mooring bollards were fixed on every fourth cross wall in the 10-foot section and part of the 12-foot section of wall, and on every third cross wall in the 224-foot length of the 12-foot section adjoining the working house, whilst at the outshore corner of the dock wall a C.I. standard snubbing post was fixed.

Along the face of the dock wall two lines of 80-pound steel rails were placed, with the top of the rails projecting ¾ inch beyond the concrete face of dock. This was rendered necessary as a means of protecting the dock face from the risk of abrasion by vessels.

Near the outer edge of the dock face, at the top, was laid a guard consisting of a 20-pound steel rail held in place by ½-inch by 2-inch flat bar clips, and ¾-inch diameter anchor bolts placed at 4 feet centres. The clips serve the double purpose of holding the rail in position, and by reason of raising the base of same ½-inch above the top of dock to enable any surface water that may collect to drain off underneath the rail.

Details of the dock wall construction are given in Figs. 3, 4, 5, 6, 7, 8 and 9, whilst the details of bent rods and reinforcement list are shown on Fig. 11.

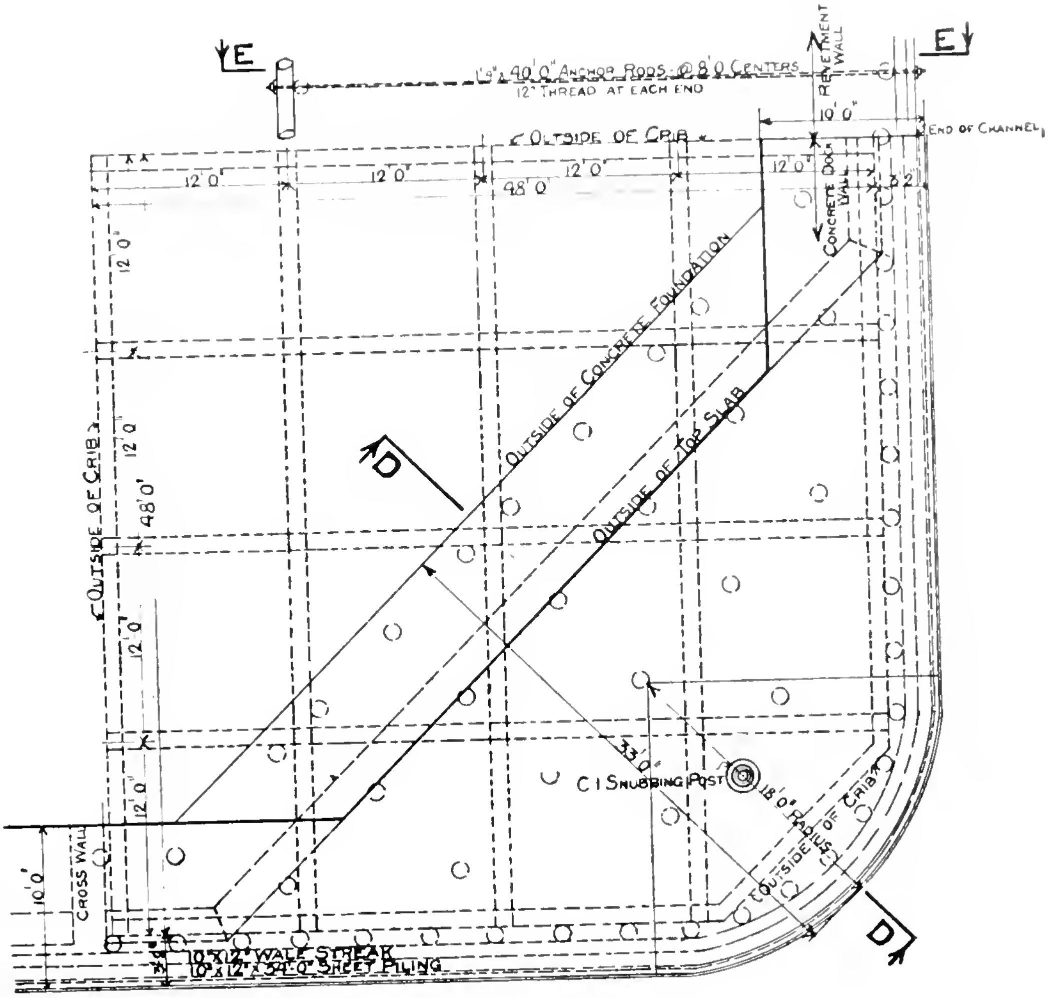


Fig. 7.—Plan at Outer Corner.

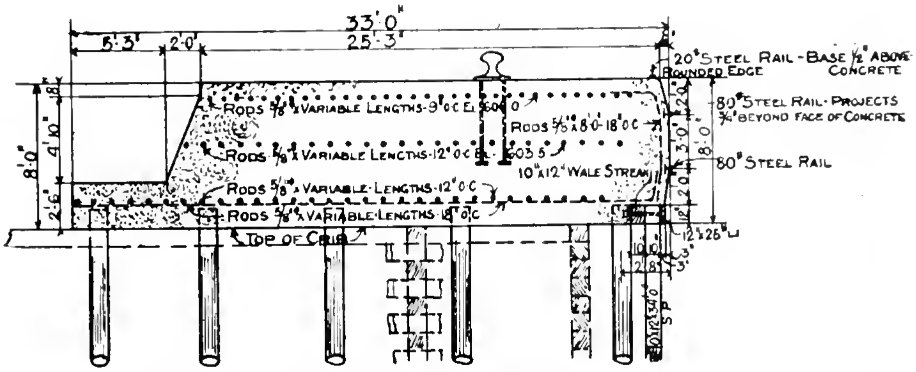


Fig. 8.—Section D D.

Revetment Walls.—Adjoining the crib end of the concrete dock wall revetment walls were built 448 feet 10 inches in length along the outshore end of the property, and 550 feet in length at right angles to last-mentioned portion and running inshore along the property line of the elevator property.

The revetment walls consist of a single row of piles, spaced 4 feet on centres to the outside of which two lines of

8-inch by 12-inch wale streaks were bolted, the wale streaks being 6 feet apart centre to centre. Outside of the wale streaks sheet piling 6 inches by 12 inches by 32 feet was driven, the piles being jetted and tapped into position and sharpened at the bottom ends in order to ensure close driving, and thus ensure perfectly sand-tight bulkhead. This sheet piling was tongued and grooved in a similar manner to the sheet piling driven in connection with the concrete dock wall, and as shown in detail in Fig. 2.

The upper wale streak was connected to each pile by means of a 1-inch diameter by 22-inch machine bolt, and the lower wale streak connected to each second pile by a similar bolt.

Each second sheet pile was connected to the upper wale

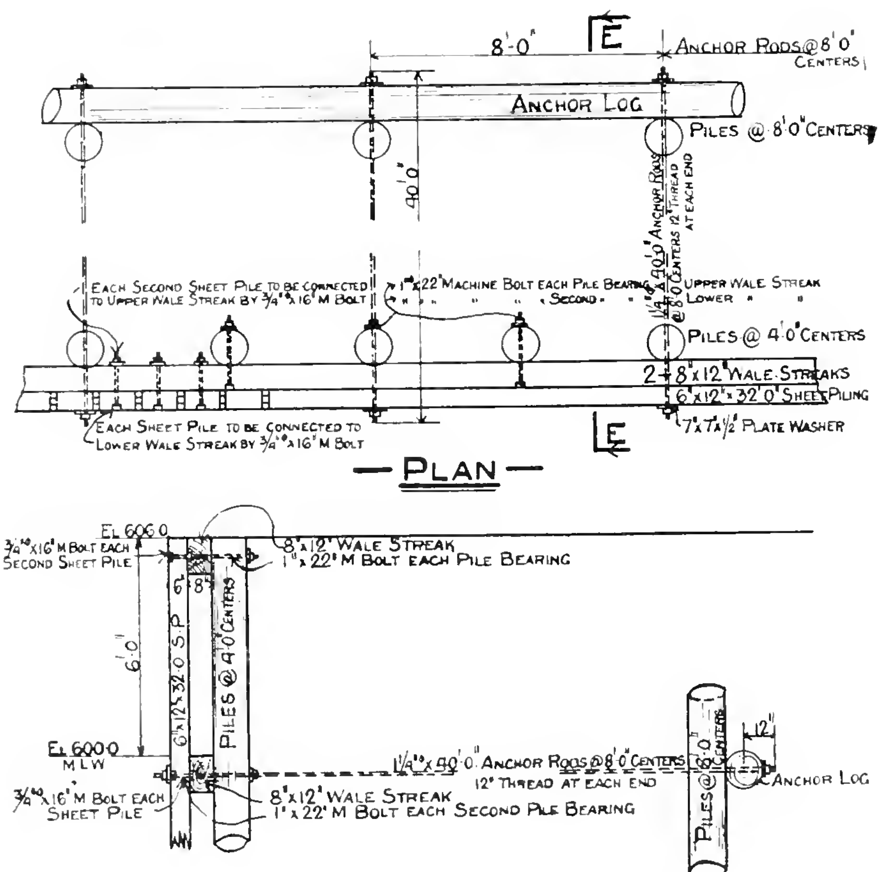


Fig. 10.—Section E E; Revetment Walls.

streak by means of a ¾-inch diameter by 16-inch machine bolt, and each sheet pile to the lower wale streak in a similar manner.

Through every second pile was passed a 1¼-inch diameter by 40-foot anchor rod, and this in turn was passed through a rear row of piles, placed 8 feet on centres, and an anchor log, held in position by the last-mentioned row of piles. The anchor rods were threaded 12 inches at each end and were fitted with wrought iron plate washers, and heavy nuts.

The pile and sheet pile cut-off and top of upper wale streak elevation was fixed at 606.0.

This elevator dock is now nearing completion, and is considered the most up-to-date dock of this particular type in the progressive port of the Twin Cities.

One of the world's newest big projects is a railway across the Sahara desert. The French government has finished its exploration. The task is difficult, but French engineers are masters. If France goes ahead plans may be ready this year.

THE HAULING CAPACITY OF LOCOMOTIVES.

At a recent meeting of the Western Canada Railway Club a paper was presented by H. D. Cameron, chief draughtsman of the mechanical department, Canadian Northern Railway, on the above subject, a portion of which we publish below.

In the earlier stages of railroading the important question of train loading was left to the discretion of the man in charge of the engine, but owing to the apparent inconsistency of the loads hauled, this method was soon changed, and the train loads for each class of engine was fixed at a certain number of cars. This method failed to discriminate between loaded and empty cars, and was followed by a system of loading by gross tonnage, i.e., it included both the weight of the car and the load.

The capacity of box cars has gradually increased in the last thirty-five years from 24,000 pounds to as high as 100,000 pounds, and the very apparent difference in hauling a train composed of empties, and one comprising loads only, disclosed the important bearing the ratio between tare and contents had on unit resistance.

This discovery led to the introduction of a system of equivalent tonnage rating.

There have been a number of different methods tried to arrive at correct equivalent tonnage. One suggestion was to arrange a special table or automatic calculator, so that the different resistances corresponding to various capacity cars, making up train, could be readily added together, and the proper tonnage obtained by balancing with calculated available tractive power of the engine. This scheme does not seem to have been generally adopted, and for present purposes the system used on the Canadian Northern Railway will be explained at length further on in the paper.

In order to follow the subject more easily we will consider it under the following sub-headings in sequence:—

1. Speed resistance.
2. Resistance due to curvature.
3. Grade resistance.
4. Tractive effort.

Speed Resistance.—Train resistance is defined as the sum of all resistances which constitute a tax on the adhesion of the locomotive. That part commonly called "speed resistance" is generally taken to mean all the different resistances that are effective on straight level track, viz.:—

1. Journal friction between journal and bearing.
2. Rolling friction between wheel and rail.
3. Atmospheric head-on resistance.
4. Atmospheric side resistance.
5. Flange friction, due to oscillation and concussion.
6. Stopping and starting resistance, or resistance due to change in velocity.

These are all variables and rather difficult to isolate and measure separately. They all act together, and, for ordinary practical purposes, it has been thought sufficient to obtain the average total resistance without determining the proportion of each individual part.

A number of the older formulæ show this resistance to be comparatively high at the start, gradually diminishing to

about twelve miles per hour, and then increasing with the speed. The later formulæ, used by the American Locomotive Company and obtained from the Pennsylvania dynomometer records, show that the resistance between five to ten miles per hour and thirty to thirty-five miles per hour is approximately constant for each different weight of car.

The following table shows the resistance of various weights of freight cars on straight level track:—

Total weight of cars, tons (2,000 lbs.)...	20	25	30	40	50	60	70	72
Resistance per ton, 5–30 miles per hour	7.84	6.62	5.78	4.65	3.94	3.44	3.06	3.00

This table shows a decided variation in resistance per ton offered by different sizes of cars. Cars weighing twenty tons require 7.84 lbs. per ton, while a seventy-two ton car needs only 3 lbs. under the same conditions. This shows quite clearly the advantage of using the largest cars possible, consistent with traffic and operating conditions, and also indicates the necessity of differentiating between large and small capacity cars.

It has been found from experiment that the resistance per ton is thirty per cent greater in empty cars than loaded ones, and this is also a factor to be considered in the tonnage of trains. From the foregoing, therefore, it is apparent that the equivalent or equated tonnage calls for some method whereby all locomotives of the same class shall be loaded so that the trains composed of loads, empties, and part loads, in different capacity cars shall offer equal resistances. The method at present in use on the Canadian Northern Railway assumes that the ideal ratio between tare and contents is two to one, and any variation from this proportion is compensated for by adding a variable percentage of the surplus tare to the sum of tare and contents. This percentage of surplus tare varies with the ruling grade for which the tonnage is determined. Thirty per cent. is used on level, twenty per cent. for grades up to 0.5 per cent., and ten per cent. for grades from 0.5 per cent. to 1.5 per cent.

Weather Resistance.—Under the heading of weather resistance is included all resistances resulting from temperature variation, wind, and snow.

Experiments by Woodbury and Beauchamp Tower show that the temperature variation has a marked effect on journal friction. At approximately one hundred degrees Fahrenheit the coefficient of friction is a minimum, and increases as the temperature is lowered. In the case of a train allowed to stand for any length of time in cold weather, considerable difficulty is experienced when starting, and it is often necessary to move small sections at a time, in order to warm up and make it possible to start the whole train. This is commonly referred to as "frozen train," but dynamometer records show that resistance in starting is not changed suddenly, as one would expect with a frozen journal, but is more or less gradual. This condition makes generous reduction on account of temperature necessary and although there have been a number of tests in this connection, there does not yet seem to be much unanimity of opinion. The following table shows reductions now in use on the Canadian Northern Railway:

Temperature Reductions—Canadian Northern Railway.

Temperature.	Reduction.
Freezing (32 degrees) or above	Nil
32 degrees above to 16 degrees above, or bad rail	5 per cent.
15 degrees to zero	10 "
Zero to 10 degrees below	15 "
11 degrees to 20 degrees below	20 "
21 degrees below to 25 degrees below	25 "
26 degrees below to 30 degrees below	30 "

In applying these temperature reductions it should be borne in mind that as soon as journals get warmed up, ordinary warm weather conditions hold so far as journal friction is concerned. In making this reduction, the proximity of the ruling grade to a terminal or point where detention is liable to occur, must be a consideration.

Wind, or the resistance offered by the atmosphere, is proportional to the square of the velocity (in miles per hour) multiplied by the cross sectional end area of the locomotive or car, multiplied by a constant equal to 0.002.

The velocity of the wind should be added or subtracted to the velocity of the train, according as it is in the opposite or same direction.

Side winds have a tendency to cause pressure of wheel flanges against the rails, thus increasing resistance considerably. Owing to the constant variation in direction of this factor, it cannot be estimated with any degree of accuracy.

Speed resistance on account of flange friction, due to oscillation and concussion, varies according to the condition of track and road-bed, and speed at which trains are run. It is not usual to consider this apart from the frictional resistance due to speed.

Momentum.—In addition to supplying power necessary to overcome the various resistances already mentioned, a locomotive has to furnish an additional amount of energy every time there is a change in velocity, either from rest, or from one velocity to another. This energy, in pounds per ton, including both the momentum of translation and the rotative energy of the wheels, axles, etc., is expressed by Henderson in the formula $P = \frac{70 V^2}{S}$ where V is the velocity in miles per hour, and S the distance in which it was acquired. Where conditions of track will admit, advantage is taken of the energy stored up in descending a grade, so that it is only necessary for the locomotive to supply the difference between the energy required to lift the train up the opposing hill, and that acquired by descent of the approach. In order to take full advantage of these conditions, the power available may be obtained by adding together the momentum energy of the train and tractive power of the locomotive.

Grade Resistance.—Grade resistance is due to the retarding effect of gravity on a train ascending an incline. It differs from the speed resistance in that it is invariable, and can be calculated exactly.

Curve Resistance.—Our knowledge of resistance due to curvature is in about the same state as that regarding some of the factors, before mentioned, in speed resistance. A good many tests have been made, but the results have not been sufficiently exhaustive, and we are still compelled to accept some approximation for our estimates. Various estimates, by different authorities, run from 0.5 lbs. to 1.72 lbs. per degree of curvature. The American Locomotive Company have taken 0.80 as a suitable mean, and this seems to be a reasonable figure to adopt. When a truck traverses a curve there are two different classes of resistance, viz.,—

1. Forces originating in truck.
2. Centrifugal and centripetal forces.

Observation has shown that on curves the tendency is for the front outside wheel to hug the rail, and the rear axles tend to lie in a radial position. Owing to the outside wheel having to travel a slightly greater distance than that on the inner rail, and on account of the wheel not being free to turn on the axle, there is a combination sliding and rolling motion of the outer wheel which further adds to the resistance. The continued relative motion between car body and truck, when traversing a curve, adds considerably to the

resistance, and efforts to reduce this to a minimum have been attempted by the adoption of roller side and centre bearings.

Experiments by Wellington show that the resistance is appreciably less with new rails, and becomes greater as the outer rail is worn to the shape of the flange. It has been found that speed influences curve resistance, and one test on a one degree curve gave one pound resistance at a speed of twelve miles per hour, and only one-half pound at twenty-two miles per hour. Experience has shown that length of wheel base considerably increases the resistance on a curve.

D—Curve in Degrees.—Centrifugal force is directly proportional to the weight multiplied by the square of the velocity. The usual practice is to elevate the outer rail a limited amount, from two to six inches, in order to counteract the tendency to lean toward the outside, and reduce the effect of the centrifugal force on the rails. From the above it is evident that a different elevation would be necessary for each different speed, and it is customary, for obvious reasons, to make this elevation suitable for passenger trains running at high speed. It is consequently too high for slow freight trains, and where curves happen to come on a ruling grade the tendency is to cause a slight increase in the resistance of the freight train. This is overcome by compensating the grade 0.04 per cent. for each degree in curvature.

Tractive Effort.—Having considered the various factors which go to make up train resistance, we now direct attention to the power developed by the locomotive, and particularly that part due to the friction between the rim of drivers and rail, and the power available for hauling train at rear of tender.

The available tractive power at slow speed is derived by equating the work done in the cylinders, to the work performed at the circumference of the drivers in one revolution. By the solution of the equation we obtain tractive effort—

$$\frac{\text{Mean effective pressure} \times (\text{piston diameter}) \times \text{stroke}}{\text{Diameter of driving wheel}}$$

The mean effective pressure is usually taken as eighty-five per cent. of the boiler pressure. In order to obtain greater accuracy it is customary to consider the resistances of locomotive and tender separate from the cars, and these may be grouped under the following headings:—

1. Internal friction of locomotive, found by experiment to be 22.2 lbs. per ton weight on the drivers.

2. Weight on drivers multiplied by grade resistance.

3. Resistance of engine and trailing trucks, and tenders taken same as car resistance in train.

4. Head-air resistance equal to $0.002\ V^2 \times A$ where V is miles per hour, and A the front area of engine (usually taken 120 square feet).

5. Curve resistance .8 lbs. per ton per degree.

6. Reduction necessary account of increase in speed, shown in attached table.

Table of Speed Factors.

Piston speed, feet per minute—

250. 275. 300. 325. 350. 375. 400. 425. 450. 475. 500. 525. 550.

Speed factor—

1.00 .976 .954 .932 .908 .886 .863 .840 .817 .795 .772 .750 .727

Piston speed, feet per minute—

575. 600. 625. 650. 675. 700. 725. 750. 775. 800. 850. 900.

Speed factor—

.704 .680 .660 .636 .614 .590 .570 .550 .530 .517 .487 .460

Piston speed, feet per minute—

950. 1,000. 1,100. 1,200. 1,300. 1,400. 1,500. 1,600.

Speed factor—

.435 .412 .372 .337 .307 .283 .261 .241

The sum of the above mentioned resistance must be deducted from the tractive effort, in order to obtain the net power available for hauling of trains. In order to illustrate this, let us take the example of a consolidation engine with the following dimensions:—

Cylinder, 24 x 32.
Wheel, 67 inches.
Boiler pressure, 180 lbs.
Weight on drivers, 104 tons.
Weight on engine truck, 12 tons.
Tender, loaded, 75 tons.

The problem is to find the net available tractive power and proper tonnage for this engine, in order that twenty miles per hour may be maintained on a 0.5 per cent. grade.

Tractive effort (MEP 85 per cent. of boiler pressure)—49,475 lbs.

Speed, twenty miles per hour, therefore piston speed of this engine is 629 feet per minute, and speed factor from above table is 65 per cent.

Available tractive effort at this speed........		32,158.75 lbs.
Resistance due to grade, account of weight on drivers 104 × 10	1,040	
Resistance due to grade and speed on tender (2-3 load) and engine truck —72 × 13.94	1,003	
Resistance due to head air—120 × 0.002 × 20 × 20	96	
Resistance due to internal friction—104 × 22.2	2308.8	4,447.80 lbs.
		27.711 lbs.

$$\text{Tonnage, 50-ton capacity cars } \frac{27711}{13.94} = 1{,}987 \text{ tons.}$$

From the foregoing it is evident that the work done by an engine is limited by either the boiler capacity or the power adhesion. Engines are compared with respect to their adhesion by comparing the factors of adhesion, i.e., the ratio between weight on drivers, and tractive effort, which usually runs somewhere between 1-4 and 1-5.

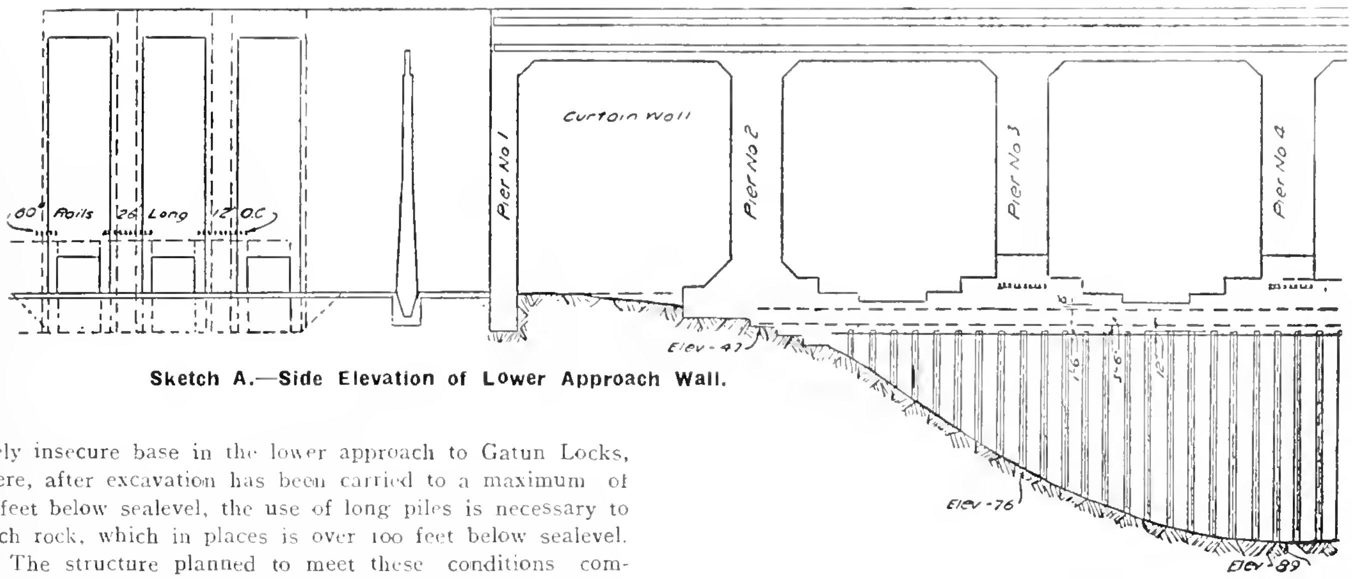
The boilers of most engines are unable to supply sufficient steam to develop full tractive effort at speeds higher than eight or ten miles per hour, and after this critica speed has been reached the boiler becomes the limiting factor to be considered in connection with load and speed. It will, therefore, be readily seen that on long level sections the boiler capacity becomes the principal factor in fixing train loads.

RAIL FAILURE TESTS.

Ninety per cent. of rail failures, as stated by Mr. M. H. Wickhorst, engineer of tests for the rail committee of the American Railway Engineering Association at the recent convention of the association, are failures either of the head or web, which constitute 50 per cent. of them; or of the base, which constitute 40 per cent. The cause of the former he ascribes to unsound ingots, and the remedy he says is a more uniform chemical structure in the ingot. For the base failures he blames laminations in the base, and suggests as a cure better mechanical rolling.

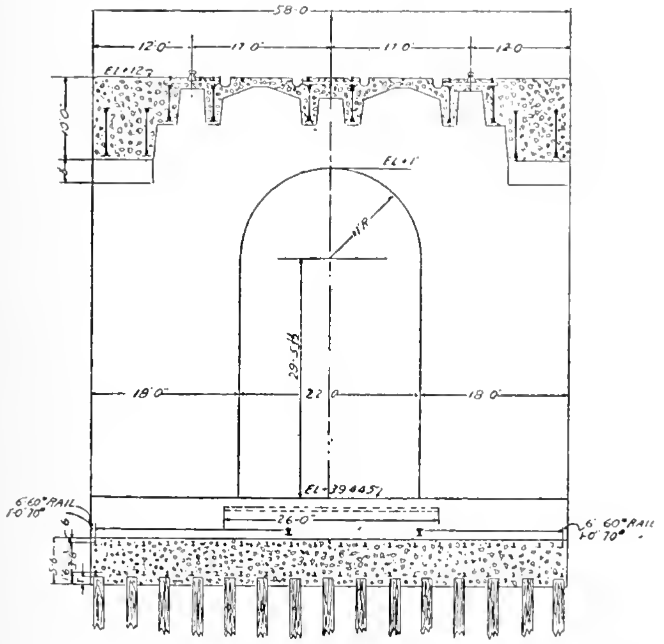
LOWER APPROACH WALL AT GATUN, PANAMA.

The lower approach wall of Gatun Locks, at the Atlantic end, differs from the five other approach walls in the Canal lock construction. The cellular form of reinforced concrete used for the upper approach walls at Gatun, Pedro Miguel, and Miraflores Locks could not be used in sea water, because of its possible effect on the steel reinforcement. The heavy U-section, double gravity-wall used for the lower centre guide walls at Pedro Miguel and Miraflores, and founded directly on rock, would be too heavy for the relatively insecure base in the lower approach to Gatun Locks, where, after excavation has been carried to a maximum of 50 feet below sealevel, the use of long piles is necessary to reach rock, which in places is over 100 feet below sealevel.



Sketch A.—Side Elevation of Lower Approach Wall.

The structure planned to meet these conditions comprises a series of piers, connected by flat spans above, to form a causeway of successive flat-span bridges. The original plans contemplated that the piers should rest on broad bases surmounting the piles, but would not be connected at bottom. Excavation revealed, however, softness in the earth overlying the rock which was not shown by the borings made at the time of determining the lock site. It became necessary to bind the piers together and protect them against transverse sliding. Accordingly, the piles, which are driven on four-foot centres, longitudinally and transversely, and on 3-foot centres for the outermost two hundred feet, are surmounted by a continuous base of concrete, which extends a foot below the top of the piles.



Sketch B.—Sectional View (Twenty, 50 ft. Apart, Support the Causeway).

This base is 58 feet wide. The bottom is level, but the top is a series of inverted stepped arches, described on a radius of 42 feet. The haunches between the successive inverted arches form the bases of the piers of the flat-span bridge. At the lowest step of the inverted arches, the thickness of the base is five feet seven inches; at the springing line it is 10 feet seven inches. Several of the arches were constructed with the soffit on a curve, but for the sake of speed in construction, with consequent economy, as well as to afford better bracing for the forms in the erection of the piers, the stepped arch was adopted. The lower part of each riser is on the circumference of a regular segment, with 42-foot radius, so the strength of the arch is not diminished. Reinforcement in the base consists of twenty continuous longitudinal rows of 70-pound rail, resting on the tops of piles; and duplicate rows of similar rail four feet six inches higher up. The side elevation of the base, and of a portion of the completed wall, is shown in the accompanying sketch marked A.

A transverse section of the wall is shown in Sketch B. Each pier, as shown, consists essentially of two piers, connected by a semi-circular arch. The horizontal normal section of each component is 18 by 10 feet; the inner sides are vertical for a height of 22 feet five and 11-32 inches, this point above the base being the springing line of the arch, which has a radius of 11 feet. On the outer faces the piers are vertical from base at elevation—39.37 feet, to the top, which is 12 feet above sealevel. The shaded sections shown in Sketch B are not parts of the pier proper, but of the spans connecting the piers in the causeway. The piers, 20 in number, are set 50 feet apart, centre to centre. The spans connecting them are carried by four 6-foot, and six 4-foot 6-inch plate girders, encased in concrete. The tops of the spans will be left uneven, in preparation for the grouting necessary to the laying of track for the towing locomotives.

The six spans of wall nearest the locks are closed by 2-foot curtain walls. This is to prevent water from surging from one approach channel to the other, between the piers, when a lock is discharging. Beyond the sixth pier the spans will be open, and the bottom of the spans will be two feet

above the water. The wall will extend 1,016 feet from the line of the fender chains, and will contain approximately 45,000 cubic yards of concrete.

BUILDING MATERIALS IN WESTERN CANADA.

With the exception of British Columbia there is very little building stone produced in Western Canada. This is due to two causes. First, the rocks which underlie the developed portions of the Prairie Provinces are of comparatively recent age and are consequently soft in character and weather rapidly; second, there are very few rock exposures in the settled portions of these provinces except in the Rocky Mountains and the foot hills.

In British Columbia there are large potential resources of building stone. They have, however, been developed only in certain localities on the Pacific Coast and have been confined to Cretaceous sandstone and certain volcanic rocks, situated on Vancouver Island and adjacent islands. Varieties of marble are also quarried on Texada Island.

While the prairie Provinces have not been proved to contain building stone in great quantity they possess large deposits of lime-rock shales and clay suitable for the manufacture of cement; also large deposits of clay and shale suitable for the manufacture of brick of various kinds, tiles, sewer pipe, etc.

The region bordered on the east by the Great Plains, and on the west by the Coast Range, does not, so far as known, contain extensive clay resources. Shales also are rare because, in most instances, the deposits of argillaceous material have been altered to slaty rock or schists.

Exploration in the Pacific Coast region has, thus far, disclosed only a limited extent of clay resources, but important shale deposits are found at Sumas Mountain, southeast of Vancouver. Surface clays are more extensive than the shale deposits and a number of these clays are found in the vicinity of Vancouver, Victoria and on several of the islands in the Strait of Georgia.

The cement plants in operation in Western Canada are situated at Babcock, Manitoba; Winnipeg, Man., (under construction); Calgary, Alta.; Exshaw, Alta.; Blairmore, Alta. (one operating and one under construction); West of Edmonton, Alta. (one under construction); Todd Inlet, B.C. (one operating and one under construction).

In the above list there are four new plants described as under construction, but all expect to be in operation in the spring of 1913. The Rocky Mountains undoubtedly contain enormous deposits of raw material similar to that used at Blairmore and Exshaw which will be developed as the demand increases.

UNEXPECTED RAILWAY TESTS.

Fifty-one thousand surprise tests were conducted by the Pennsylvania Railroad last year to test the alertness of its men in heeding signals. In these there were 510 failures on the part of the men to obey the signals, and the railroad company, arguing that each of these failures contained the possibility of an accident, protests vigorously against a bill introduced into the New Jersey Legislature requiring the railroad to give previous notice in writing to the engineman where tests of apparatus are to be made.

RECOMMENDED PRACTICE IN RAILWAY LOCATION.

At the recent annual meeting of the American Railway Engineering Association, the following notes for railway location were presented by a committee on "The Economics of Railway Location":—

Value of Maintaining Original Profile.—Railroad profiles change in the course of years. It is a well-known fact that fills settle, causing deep sags in the grade line. The raising of tracks through cuts is cheaper than ditching, but is responsible for summits in the cuts.

In the early days it was not as thoroughly realized as it is at the present time that maintenance of way is chiefly a matter of drainage. Shortage of money was also responsible in a large measure, for narrow cuts which were difficult of drainage. In the effort to get away from this condition, and to secure a ditch, tracks were raised, thereby causing steeper grades than were originally projected. Every cut being followed by a fill, the sequence of raised cuts and depressed fills has caused a wide variation from the original ruling grade.

On some lines, where the profile has been checked, it has been found that stretches of 0.3 per cent. grade have become 1 per cent. If places of this character occur near a point of heavy resistance, an immediate effect on the tonnage of a train is the result. When an engine is working with its bar well forward, with the fireman tired out, the fire dirty, and the steam pressure dropping, such places will cause the stalling of a train, and in a short time the frequent delays will result in decreased tonnage rating.

Raising tracks is not as economical as the section foreman and supervisor would lead us to believe. While better drainage is undoubtedly secured, it is generally better practice to clean the ballast, and widen cuts to secure a ditch, and to raise track only when it becomes necessary to put roadbed to a proper line and surface. On such occasions, grade stakes should be used to establish the grades.

On many railroads an effort has been made to place permanent monuments, so that the track could be kept at a constant elevation. The difficulty of maintaining monuments along a roadbed is well known. They are not only likely to be a menace to the lives of the trainmen, but they are constantly settling, and being knocked by sectionmen, and occasionally by derailments. However, the importance of placing permanent monuments cannot be over-estimated.

Compensating Old Roadbeds.—In the early days of railroading, compensating for curvature was practically unknown. For many years it was probably unnecessary. Compensation for curvature is not vital to small trains running at speed. The resistance due to curvature is principally felt by heavy tonnage trains on ruling grades where the engine is rated at a high percentage of its cylinder tractive power. Various experiments have been made to determine how much reduction in grade would compensate for the added resistance of curvature. It has generally been the practice to compensate this at a stated amount, and, while this method is not as accurate as could be desired, it is very much better than no compensation at all. From considerable observation of the influence of curvature, together with the examination of numerous tests of its effect, it is felt that some rules can be laid down which will improve the present practice. The rules follow:

Rules for Grade Compensation.—1. Compensation .03 per degree:

(a) When the length of curve is less than half the length of the longest train.

(b) When a curve occurs within the first 20 ft. of rise of a grade.

(c) When curvature is in no sense limiting.

2. Compensate .035 per degree.

(a) When curves are between ½ and ¾ as long as the longest train.

(b) When the curve occurs between 20 ft. and 40 ft. of rise from the bottom of the grade.

3. Compensate .04 per degree.

(a) Where the curve is habitually operated at low speed.

(b) Where the length of the curve is longer than ¾ of the length of the longest train.

(c) Where super-elevation is excessive for freight trains.

(d) At all places where curvature is likely to be limiting.

4. Compensate .05 per degree wherever the loss of elevation can be spared.

An illustration will show what can be accomplished by compensation of curvature on old roadbeds:

Take a 0.5 per cent. grade five miles long, with an average curvature of 60 deg. per mile, without compensation. If the maximum curve is 6 deg. and the curve equal in length to the longest train, the curvature will have the same effect in limiting tonnage as a grade of 0.24 per cent. This, added to the 0.5 per cent. grade, would make a ruling grade of 0.74 per cent. The effect of the curvature on the five miles of grade would be 300 deg., which, at an average of 0.035 per degree, would amount to 10½ ft. If this 10½ ft. is added to the 132 ft. of rise in the five miles of grade, it will be equivalent to 142½ ft., or 28½ ft. to the mile, which is equal to a 0.54 per cent. grade. If this 0.54 per cent. compensated grade is laid so as to be superimposed immediately above the present roadbed, it will be found that by re-ballasting the track to permanent stakes on a 0.54 per cent. grade, a new ruling grade can be established, which will be 0.2 per cent. below the 0.74 per cent. equivalent to the 0.5 per cent. uncompensated grade. On a grade of this length, it will be possible to haul nearly 25 per cent. greater tonnage per train, thereby securing a very large economy in operation for a small expenditure of money.

Compensation of Low Grades.—The effect of curvature on low grades is generally greater than on heavy grades, provided the length of train is what would be justified by the low grade. In speaking of low grades, levels, 0.1 per cent., 0.2 per cent. and 0.3 per cent. grades are referred to.

On double track railroads, particular attention should be paid to curves, whether uphill, downhill, or level, at places where steam is being taken by the engine in moving in either direction. On virtual level grades each track should have its tangents slightly raised and its curves slightly sloping downhill, so that the pull by the engine may be uniform, and the resistance of the line constant. The value of keeping the line resistance constant becomes more important as the length of the train increases. One of the prime objections to hauling a long train is the danger of parting, and in this danger curvature plays an important part. If the line is crooked, having many short curves, it is usual for the slack of the train to be constantly taken up and let out. If the engine runs out on a bit of straight track, when the rear of the train is bunched on the curves, it will accelerate faster than the other end of the train. Unless the engineer is watching, and using the brakes slightly, he may pull out a drawbar. If, on the other hand, the front end of the train is on a curve, and the rear end on straight track, the tendency is for the rear end to run in on the front end, and break a knuckle. It should not be supposed that it is impossible to have different classes of compensation on each track of a double track railroad.

Super-Elevation.—From a scientific standpoint (not always from a financial view), it is evident that a six-track railroad is the most desirable for a road that handles a three-speed service. This will give a passenger track, a fast freight track, and a slow freight track in each direction. Without attempting to discuss at this time what will be gained by the operation of a six-track railroad, it should be said that as many tracks as possible are justified if a standpoint of super-elevation alone is considered. Of course, it becomes necessary for a train to stop occasionally on a curve, and for that particular case the super-elevation is always wrong.

Inasmuch as no super-elevation at all is necessary at very low speeds, it may be eliminated entirely on tracks that are used exclusively for standing cars, and very low super-elevation, if any, should be used in yard tracks.

On a single-track railroad carrying more than one class of traffic, there are two ways to treat super-elevation:

(1) Make the freight tonnage rating as great as possible, and in accordance with the ruling grade. In this case, it will be necessary to elevate the curves for freight speed, and run the passenger trains slowly over the ruling grades.

(2) Use a higher super-elevation for passenger speeds, and decrease the tonnage rating to make up for the increased resistance caused by the wheels of the freight trains binding against the lower rail.

Single-track railroads which are crooked can rarely haul as high a percentage of rating as double-track railroads, on account of the super-elevation being wrong. It is very easy to see that every down-grade becomes an up-grade for movements in the opposite direction on a single-track road. Inasmuch as the movement downhill is likely to be faster than the it is uphill, the super-elevation must be made for the downhill movement or introduce speed limits on downhill trains.

Resistance, Train, Total, Including Track.—On single lines that are exclusively for freight, super-elevation on ruling grades should be made for not over 15 miles per hour. It is less expensive to slow down the descending movement than to reduce tonnage rating on account of excessive super-elevation.

This is especially true on curves of large central angle. As an example, a curve of 18 deg. is cited. Two engines (one helping) hauling 3,500 tons of coal ordinarily stalled on an 8 deg. 30 ft. curve with 185 deg. central angle with 5½-in. elevation. The elevation was reduced to 3 ins. and no difficulty was had. This curve was compensated .04 per degree and was an 0.85 per cent. grade.

On many mountain roads a long train may be on seven or eight curves at once, and when such is the case, observation of minor points is of great value when tonnage is the main issue.

Spirals.—Without discussing the theory of the spiral as affecting railway grades, it should be said that the object of the spiral is twofold:

(1) To afford a run-off and a run-on from a level cross-section to a super-elevated cross-section.

(2) To ease the horizontal passage from a straight line to a curve.

It is evident that in passing from a level position to a super-elevated position, when the inner rail of the curve is laid at grade, the centre of gravity of the mass of the train

must be raised through a distance equal to one-half the super-elevation. This is generally a minor rise, but in order to haul uniform tonnage this minor point should be carefully observed, especially where limiting conditions are found, such as places near the end of a long-continued effort. It has been proposed in the past that the inner rail be depressed a distance equal to one-half of the super-elevation, and the outer rail be raised the same amount. While this has been objected to by some railroad men, it can certainly be done and so maintained, and from a tonnage haulage standpoint it is desirable. It is submitted that the railway of the future, which is scientifically operated, will find conditions such as these limiting their tonnage unless care is taken. While it might be said that refinements in the track are unimportant, it should be borne in mind that, in order to realize the full value of improvements, these matters must be taken into consideration. A combination of correct conditions results in the most effective operation.

Reverse Curves.—Curves that reverse without any tangent between them mean operating expense. Not only must the super-elevation change abruptly, but the trucks must change their position in the same manner. It is considered good practice to leave room between the points of spiral for four freight cars to straighten up after they change direction. On most new construction, provision is made for at least 1,000 ft. between curves, and this practice is recommended unless great expense is involved.

Effects of Tunnels.—Many railroads are suffering today on account of the fact that during the early days of construction it was not thoroughly realized that a tunnel might be a limiting feature. The following are the causes of the limiting effect of tunnels: (1) A tunnel is dark, making the crew less confident. (2) A derailment in a tunnel is almost sure to result in serious damage and loss. (3) The heat in long tunnels, especially if of small section, is intense. (4) The track conditions, such as line and surface, are never as good as on the outside. (5) The rail is generally damp, causing either the excessive use of sand, or the slipping of drivers. (6) Drainage in tunnels is usually bad, and difficult to improve. (7) There are usually speed restrictions in tunnels. (8) It was formerly the practice to carry maximum grades through tunnels in order to shorten them. This serious defect in many cases makes tunnels the ruling points. (9) In tunnels of small section the use of helper engines is undesirable on account of the heat. (10) The smoke and gas add to discomfort of operation. (11) The impracticability of firing in long tunnels causes a drop in steam pressure.

There have been many plans devised for tunnel ventilation. Most of them are successful under some circumstances, but none is successful under all conditions. Long tunnels are generally built by means of shafts, and these shafts are sometimes left open to aid the ventilation. If the heat in the tunnel is greater than that outside, shafts will help when the atmosphere is low in humidity. When the humidity is high, shafts make but little difference in tunnel conditions. This is unfortunate, as tunnels at such times are very foul. Disc fans used in the shaft will operate satisfactorily sometimes, but their efficiency seems to vary about the same as the open shaft. Pure air blown down shafts is successful at times, but if the shaft is near the centre, it generally happens that only one end of the tunnel is cleared out, the air remaining stationary at the other.

The Churchill system of ventilation, by which pure air is blown through the tunnel from one end through nozzles fitted at the sides of the tunnel, is successful, if the enginemen operate the locomotive so that the smoke is blown ahead of the engine. If two engines are used ahead on a train, and it is necessary to work the second engine, the position of the front engineer is unbearable. If one engine is used in the rear and one in front, and the smoke and gas from the second engine reaches the first one, the front engine crew are in the same position as in the case of the double-header, but if the train is skilfully handled, the smoke and gas of the rear engine will not reach the head engine. In tunnels where the grade inside is considerably less than the ruling grade, it is sometimes found possible to shut off one engine entirely, and in that case there is no difficulty, provided that the train does not move faster than the air current.

The natural tendency is to drive the engine as hard as possible through the tunnel on a heavy grade in order to get through quickly. The speed of the air currents in the Churchill system of ventilation in a tunnel a mile long usually averages about 8½ miles an hour over the whole distance. If the tunnel is being worked to anywhere near its capacity, the additional time in the tunnel may seriously limit the number of trains that may be put through. It has been found, however, that if the tunnel is cleaned out by the ventilating apparatus before the passage of each train, there is little difficulty in getting through. As a rule, the engine crews prefer this method.

Double-track tunnels are of sufficient section so that there is little discomfort in a tunnel a mile long, even if the locomotive is fired all the way through. The practice in Europe has always been much better than that in the United States in that even with single-track tunnels their section has been large enough so that they are less uncomfortable than those in this country. Tunnel ventilation in Europe is largely restricted to the dilution of locomotive gas with plenty of fresh air rather than driving the smoke and gas ahead of the engine.

In the construction of new tunnels, an effort should always be made to reduce the grade in the tunnel considerably below the ruling grade, so that there may be no need of touching the fire during the passage through the tunnel. Ample section to secure good conditions is essential. In this connection it should be noted that the effect of long single-track tunnels of narrow section on the ruling grade is to reduce the tonnage rating in the tunnel by 10 per cent. at least.

THREE NEW ALLOYS.

In their last official report as chemists to the American Institute of Metals, Arthur D. Little, Inc., of Boston, mention three new alloys among the various items of recent progress in the metal industry.

A French patent has recently been issued covering the production of two types of alloys from copper, zinc and silicon which are claimed to possess great tenacity, resistance to acids and alkalis and to be capable of rolling into finished shapes.

Another new alloy has been patented by the Ajax Metal Company, composed of iron, nickel and copper, which is claimed to be non-corrosive, malleable, of great tensile strength and capable of being rolled, drawn or cast.

A new type of pyrophoric alloy has been patented in Germany which consists of the addition of 5 per cent. metallic cerium to an alloy of manganese and antimony. The inventor claims excellent pyrophoric properties from this alloy which is essentially different from the other alloys of this type in which cerium is the main source of the pyrophoric characteristics.

COSTS OF CONCRETE PAVEMENTS.

In a paper before the American Society of Engineers and Contractors, and reprinted in the Journal of the Society, pp. 435 to 450, C. M. Boynton, inspecting engineer, Universal Portland Cement Company, writes on "Concrete Pavement; Methods and Cost of Construction." The following data is abstracted from same:—

An analysis of the material costs of one-course and two-course work will show that the difference is so very slight as to be doubtful of estimation. However close an approximation an estimate may be, it cannot be exact, and, therefore, it will readily be seen in the following formulas that the main consideration in choice of type of pavement must necessarily be dependent upon the materials available; and the type chosen will be that to which thy are best adapted. This formula is based on Taylor & Thompson's Table of Proportion.

Considering: C equal cost of cement per barrel,
G equal cost of gravel per cubic yard,
S equal cost of sand per cubic yard.

Then, for one-course work of 1:2:3 mix, 7 ins. thick, the material cost per square yard of pavement is .325C plus .0975S plus .146G; while for two-course work, 7 ins. thick, composed of 1:2½:5 base, and a 1:1½ top mortar, the material cost per square yard of pavement is .342C plus .1045S plus .133G.

These two formulas show the tendency to equalize the cost by small compensating differences in the several quantities and are given here to illustrate this point.

With good equipment and an average gang the actual cost of mixing and placing should not exceed 7 cents. per square yard for 7 ins. of concrete. To this should be added a cost of 3 cents per square yard for finishing and labor necessary for handling the forms, making a total for one-course work of 10 cents for mixing and placing. As has been stated, there is a slight difference in the cost of placing single and two-course work, with the advantage in favor of the former.

Placing expansion joints is such a simple operation that 1 cent per square yard should cover the cost. To this must be added the cost of metal joint and tarred felt delivered on the job, or the cost of filling the joint with a plastic filler.

On city streets the water supply is not a problem; but on country highways, where it is necessary either to haul or to pipe water a considerable distance, it is advisable to make a careful survey of the situation. In estimating the cost of water the amount required for keeping the pavement damp for a period of five days must not be neglected, and as this is an indefinite quantity dependent upon weather conditions, only an approximate cost can be suggested. On the Wayne County, Michigan, work the water for each road is costing $3.50 per day (the wage for a man looking after the pumping), plus oil and gasoline required in operating the engine and pump. Water for the Mukwanago Road in Milwaukee costs 1¼ cents per cubic yard of pavement. In this case the water is purchased from the city of Milwaukee or its suburbs. In both cases the contractor's and builder's equipment must include the necessary engines, pumps, piping, etc.

The cost of hauling water for use in constructing country highways of concrete is often an item worthy of careful consideration. The method of supplying water by piping is considered by the majority of contractors as most economical. Where water is available under sufficient pressure the pipe line can be attached directly to the city main, thus eliminating engine and pump, but where water is taken from a well, creek or river in vicinity of work, an engine and pump will be required. The cost of gasoline engines varies with rated horse power from approximately $105 for a 2-h.p. engine to $320 for a 9 h.p. The cost of pumps would vary according to the capacity pressure required and the conditions under which work would be performed.

On one job in the vicinity of Milwaukee, 7,200 lin. ft. of 2-in. pipe at $6.80 per 100 ft. cost $489.60, and the laying, $20 per mile, amounting to $27.20, makes the total cost $516.80, or $0.072 per foot. On the other job 11,200 ft. of 2-in. pipe cost $1,008 laid, or $.09 per foot. For supplying water, the city of Milwaukee received $.005 per cubic yard of concrete mixed and $.005 for each square yard of pavement, making a cost of $.00583 per square yard of finished pavement.

Where the construction is small, the installation of efficient pumping equipment may not be justified, in which case hauling in tank wagons can be resorted to. One team hauling tanks having upwards of 350 gals capacity will supply a mixer of ⅓ cu. yd. with sufficient water for a day's run, provided the haul is 1½ miles or less. On one job of 4,800 sq. yds. in Wisconsin the water cost $75 for the entire work, plus the cost of hauling and pumping, which was $7 a day for 10 days. Another contract was $10 for water and $4 a day for hauling. This work covered 3,500 sq. yds., but the haul was short and one team working half a day could keep the mixer supplied.

In discussing the cost of concrete pavements, a few examples of actual construction will help to make clear the division of expense. The first pavement was laid recently in a small town in the central part of Illinois, totaling 5,000 sq. yds. The total cost of the work was $3,964.02, excluding cost of equipment, which consisted of a ½ yd. Koehring mixer of the latest type and a 4½-h.p. gasoline engine, and also excluding the cost of the water for mixing and sprinkling. The pavement was 45 ft. wide and uniformly 6 ins. thick. The cost of the work was divided as follows:—

Superintendence	$ 140.00
1,457 bbls. cement	1,547.15
Sand, stone and gravel	1,284.97
Labor	560.07
Lumber and forms	35.00
Bitumen and creosoted blocks for joints	48.67
Coal and oil for mixer and engine	30.75
Excavation	307.41

A summation of these figures gives the cost of this road as $4.76 per cubic yard or $0.79 per square yard.

During the summer of 1912 Milwaukee County, Wisconsin, constructed several concrete highways to the south and southwest of Milwaukee. Data on a two days' run from one of these jobs were collected. Twenty-four men and a ⅓ yd. Smith mixer of the dumping type were able to place 94.1 cu. yds. or 470 sq. yds. of 9-ft. road 7 ins. thick at a total cost of $364.41, exclusive of cost of grading and interest and depreciation on equipment. The materials were furnished free to the contractor on the siding nearest the work and hauled to the job at his expense.

In figuring the cost of the road, the cost of materials to the county was included with the cost of mixing and placing carried by the contractor, and are itemized as follows:—

111.5 bbls. cement	$115.96
93 yds. bank-run gravel	94.86
Water piped from the city	19.27
Baker protection plates for expansion joints	29.07
Coal and oil for engine	4.00
Labor	101.25

This gives a cost per cubic yard of $3.98 and $0.79½ per square yard.

Another piece of construction work for Milwaukee was a road 18 ft. wide and 7 ins. thick. The work was done by 20 men, using a ½ yd. Chain Belt mixer with chute delivery. The water was piped along the road from the city as in the preceding case, but a 4½-h.p. gasoline engine was necessary to force the water up to the head required. The work recorded covered a period of four days and cost $1.128.46, exclusive of equipment and grading. The cost of piping and water for this and the preceding job was fully accounted for in a former paragraph. The cost of the work was divided as follows:—

414 bbls. cement	$430.92
92 yds. sand and 152.3 yds. gravel	340.84
Water	60.20
Baker protection plates for expansion joints	76.50
Coal and oil for mixer and engine	7.50
Labor	232.50

From these figures we arrive at a cost of $4.70 per cubic yard and $0.91 per square yard for the pavement.

In southwestern Michigan a short strip 708 ft. long, 9 ft. wide and 7 ins. thick of 1:2:4 concrete cost $717.83, exclusive of grading, equipment and water. The equipment consisted of a 7-cu. ft. Clover Leaf mixer, necessary wheelbarrows and shovels and lumber for forms. The gang on this road was much smaller than that of any of the other roads. Details of the cost were:—

225 bbls. cement	$234.00
69 yds. sand	37.59
136.35 yds. gravel	196.34
Gasoline and oil for mixer	10.00
Baker plates	96.00
Labor	144.00

This gives a cost per cubic yard of $4.68 and per square yard of $0.91.

In the west central part of Michigan 2,580 ft. of concrete 9 ft. 2 ins. wide and .55 of a foot thick were constructed by a township as an experiment. A gang of 12 men using a 7-cu. ft. side delivery Koehring mixer did the work for a total cost of $3,302.62, divided approximately as follows:—

746 bbls. cement	$ 870.00
655.9 yds. sand and gravel	553.28
Baker protection plates and filler	170.12
Labor	1,690.50

These figures give a cost of $7.28 per cubic yard or $1.31 per square yard. Had the cost of grading, excavation and culverts been added to the above, the cost of pavement would have been increased to $8.73 per cubic yard or $1.46 per square yard.

The following work was constructed in the north central part of Illinois during October and part of November of last year. The road is 5,500 ft. long, 12 ft. wide and has a uniform thickness of 6 ins. The total cost, not including water, macadam shoulders and equipment, was $7,089.42. The equipment consisted of a ½ yd. Koehring mixer, road grader, plows, scrapers, road roller and the necessary wheelbarrows and shovels. The cost was as follows:—

2,274 bbls. cement	$2,333.65
720 yds. sand	582.40
1,185 yds. gravel	1,787.03
Operative cost of mixer	51.99
Baker plates and creosoted wood blocks for expansion joints	160.03
Labor	2,282.52

The total of these figures determines the cost per cubic yard as $5.80 or $1.06 per square yard. No information was obtained on the cost of water for this work.

METHODS OF ESTIMATING STREAM FLOW WHEN STREAMS ARE FROZEN.*

By W. G. Hoyt.†

The usual methods of obtaining daily discharge of streams under open-water conditions may be briefly given as follows: Daily gauge heights are obtained from a gauge maintained at a permanent datum. Current meter measurements are made to determine the flow at different stages of the river. The results of these measurements are plotted with gauge heights as ordinates and discharge in second-feet as abscissas. A curve is drawn through these plotted points and the daily discharge is obtained by applying the mean daily gauge heights to the curve. If the channel is fairly permanent, such a curve will remain constant and measurements made from year to year will plot in close proximity to it.

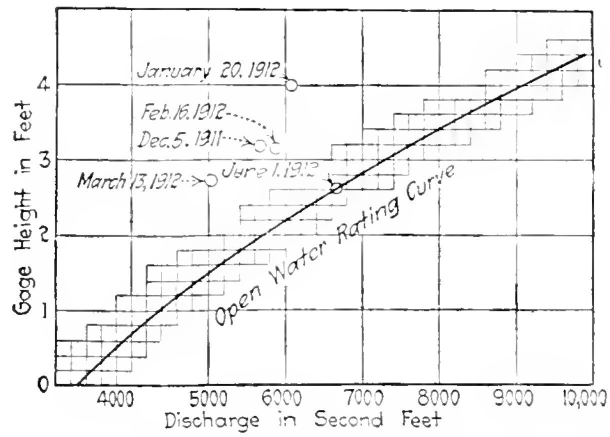


Fig. 1.—Open-Water Rating Curve for Rainy River at International Falls, Minn.

(The curve is based on a large number of current meter measurements and plotted winter measurements showing how relation between stage and discharge is destroyed by ice conditions).

When the temperature falls below freezing, numerous conditions affecting stream flow are liable to be produced which tend to destroy the otherwise fairly constant relation between stage and discharge, thus making it necessary to employ special methods to arrive at the true daily discharge. (Fig. 1.)

Measurements of discharge which indicate the flow at the time they are taken are fundamental in any method for winter estimates. The accuracy of the results will depend largely on the frequency of the measurements, and, in connection with records of gauge heights, temperature, precipitation and ice conditions, they form the basis for estimates of flow.

Precipitation is the cause of all run-off, and since temperature is the controlling factor in regulating the rate at which winter precipitation reaches the streams, it follows that temperature is, in general, the most important governing factor and should be given special consideration in making winter estimates of runoff.

Estimates of stream flow under winter conditions may be made by the following methods:

* Abstract of work of the United States Geological Survey.

† District Engineer, Water Resources Branch, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

1. By the application of the gauge heights of the water surface to the open-water rating, when it is known that the controlling point for the gauge is clear of ice and that no backwater exists at the gauge.

2. By developing a curve based on discharge measurements and gauge heights to the water surface to which is applied directly the open water-gauge heights as taken by the observer.

3. Basing the flow directly upon discharge measurements, taking into account the climate, ice conditions and gauge heights.

(a) By the eye method, working directly with the daily discharge, varying it between times of measurement by inspection of the temperature and precipitation records and gauge heights, and adjusting by comparison of results for nearby stations.

(b) By applying the open water rating to the gauge heights and applying to these discharges a coefficient as determined at times of measurements, varying the coefficient according to a knowledge of temperature, precipitation and ice conditions.

COMPUTATION OF FLOW DURING WINTER PERIODS OF........................RIVER
AT
NEAR........................MONTH OF........................19....

Day	Max. Temp.	Min. Temp.	Pre-cipi-tation	Ice Thick-ness	Gage Height Water Surface	Esti-mated Back-Water	Effec-tive Gage Height	Esti-mated Dis-charge	Notes
1									
2									
3									
4									
30									
31									

MEAN DISCHARGE SEC.-FT.
..................To..........
..................to..........
..................to..........
Probable Maximum...
Probable Minimum.....

TOTAL MEAN
Sec.-Ft. per sq. Mile
Runoff Depth in Inches
Runoff in Acre Feet
Accuracy

Computed by.......
Checked by.........

ENG. NEWS

Fig. 3.—Suggested Form of Special Computation Sheet for Records and Estimates of Stream Flow Beneath Ice.

(c) By the graphic method, plotting the records of temperature, precipitation and gauge heights to the water surface and determining the amount of correction necessary to apply to the gauge heights in order that the open-water rating table may be used, basing the variation in this correction between times of measurements directly on the variations in gauge heights and temperature conditions and modifying the same by record of precipitation and ice conditions.

The accuracy of Method 1 depends primarily upon the location of the station. Stations are now located at several points in the United States and Canada at which this method is giving excellent results, but, as their number is few, the method can only be used in special cases.

The accuracy of Method 2 will depend largely upon the number of discharge measurements and their conformity to a true curve. It is believed that this method can be used at former stations than can Method 1.

The methods described in No. 3 will apply at practically all gauging stations which are affected by ice conditions. Method 3 (a) is the one now commonly used, but it is believed that 3 (b) and 3 (c) will give better results than 3 (a) and that Method 3 (c), which is described more fully hereafter, has an advantage over either 3 (a) or 3 (b).

A discharge measurement taken under ice conditions, when plotted to the open water gauge heights (Fig. 1), will always plot either on the open water curve or to the left, showing that the disturbing conditions result in a backwater effect. Therefore, to arrive at the true flow for a given gauge height it is only necessary to determine the magnitude of this backwater effect at the gauge. Since the formation of ice is due entirely to climatic conditions, it follows in general that the amount of backwater varies directly with climatic conditions.

Having determined accurately the amount of backwater at stated intervals by discharge measurements, it is possible to determine the backwater effect between times of measurement by constructing a curve of backwater. Such a curve can be drawn by following the observed gauge heights and the climatic and other conditions which cause the backwater.

The development of this method has been largely based on studies made during the winter of 1911 and 1912 on the Rainy River, at International Falls, Minn. At this point there is a regular current meter gauging station just below the plant of the Minnesota and Ontario Power and Paper Company. The Canadian Department of Public Works determines the flow at the plant by means of wheel ratings and the same flow is also computed by the United States Geological Survey at its regular gauging station. The average monthly variation in flow, as determined by these two methods during the five months from June to October, 1912, was 0.75 per cent.

The Rainy River, for some miles below the power plant, has a very slight slope, so that notwithstanding the fact that this part is usually free from ice, due possibly to the presence of acid from the paper mill and to the agitation of the water as it passes through the wheels, there is more or less backwater effect due to the formation of ice which occurs below the open water stretch.

We have, therefore, at this point a gauge station which is so affected by ice that the regular methods of computation of daily discharge do not apply, and also a station where the true daily flow is obtained, so that data are available for studying the effect of the ice. This study has been made graphically on Fig. 2, which shows the following curves:

1. The observed daily gauge height for the gauging station below the dam.

2. The corrected daily gauge height obtained by using the rating table for the station below the dam and finding the daily gauge height corresponding to the daily discharge given by the records of flow through the plant (no water passes over the dam).

3. The mean daily temperature at the gauging station.

4. The daily precipitation at the gauging station.

5. The daily backwater effect obtained by taking the difference between the observed and corrected gauge height curves, which shows the amount which the recorded gauge height reading should be corrected to give a gauge height which will, when used with the open water rating table, give the true discharge.

A study of the mean temperature curve and the backwater curve shows that these two curves tend to follow the same general direction, which confirms the assumptions previously stated. This is also borne out by records at other stations, and it is therefore believed that this relation will hold on the average steam, unless it is destroyed by unusual precipitation or ice conditions; that is, ice jams which cannot be taken into account in the construction of the backwater curve.

Based on this assumption, it is possible to construct the backwater curve from a comparatively few measurements of

discharge distributed through the period affected by ice from which the backwater effect on the days on which they are taken can be obtained. By plotting these values as ordinates and days as abscissas under a daily temperature curve, it is possible to draw a curve through the point so plotted, following the same general shape as the temperature curve, which will give the backwater conditions for each day. In drawing this curve, account should be taken of the daily precipitation and of ice jams or other unusual conditions which may introduce backwater effect.

The circles plotted with the backwater curve (Fig. 2) show the backwater as determined from the discharge measurements on various days during the period in question. If these and the temperature records had been the only data available, a backwater curve could have been drawn which would have approximated the true backwater curve which was obtained from the daily records of flow over the dam. Of course care must be taken to study all the possible conditions which may affect the estimates.

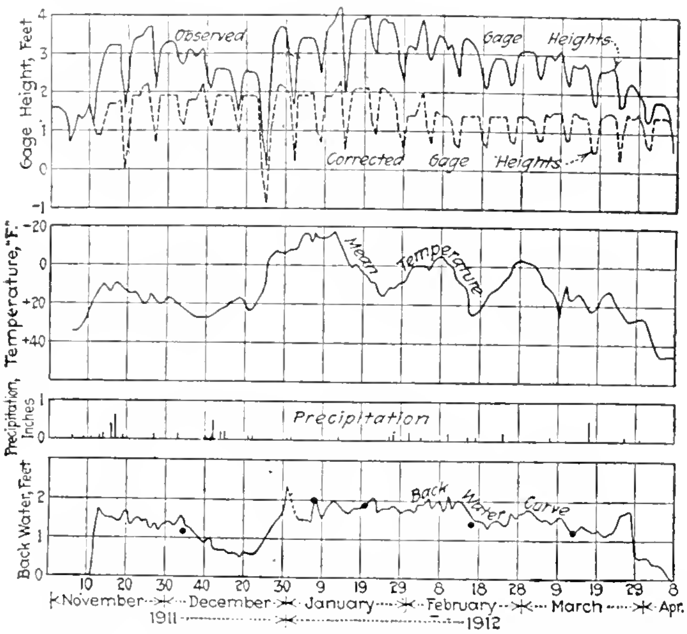


Fig. 2.—Various Observations at Rainy River Gauging Station, International Falls, Minn., November 1, 1911 to April 8, 1912.

(The observed gauge heights have been corrected on the basis of the backwater curve. The mean temperature was averaged in 5-day periods. The backwater observations were taken at the gauge. The full circles on and near the backwater curve indicate dates of current meter measurements).

Aside from giving more accurate results, this method has an advantage over any other method that has been devised, in that it gives a complete record of all the steps taken, so that the estimates may readily be reviewed or checked by a second person and show at once exactly how they were prepared.

The data necessary for use with this method are:

1. Daily gauge heights observed to the water surface through a hole made in the ice if the section is frozen over.

2. Records of daily temperature at the gauging station.

3. Record of mean precipitation over the drainage area above the gauging station.

4. Measurements of discharge* at intervals during the period when frozen conditions existed.

*See "Engineering News," Sept. 12, 1912, for methods of making.

As already stated, the accuracy of this method will depend upon the frequency of these measurements. If the winter conditions are more or less constant, less frequent measurements will be required, as it is during periods of thaws that the principal uncertainties occur. Regardless of this method, a special computation sheet should be used and some fairly standard method followed, which will bring winter estimates on a standard basis so that full records may be had. The headings on the typical card given in Fig. 3 are suggested for such a form.

In connection with this study, I wish to advance the following tentative conclusions, based upon observations of conditions in Minnesota since the fall of 1911:

1. Ice conditions usually cause backwater at the gauge.

2. Backwater increases rapidly at the beginning of each cold period, partly dropping off later.

3. The amount of backwater will tend to vary with the temperature.

4. Stream flow will drop off suddenly, following a cold period and will be partly regained later.

5. Stream flow tends to decrease when temperatures go below 32 degrees, but the flow tends to increase with any rise in temperature, especially when the minimum temperature goes above 32 degrees Fahrenheit.

6. A snow cover on the ice may cause increased backwater.

7. Flow may increase without a rise in gauge height, due to the wearing away of the ice.

SOME CANADIAN WATERWORKS STATISTICS.

On the average each person in Canada served by waterworks uses 113 Imperial gallons of water a day and pays $4.12 a year for it.

New Brunswick has the highest per capita consumption in Canada, viz., 161 gallons per head per day, while Manitoba and Saskatchewan have the lowest—46 gallons per head per day. The more general use of meters in the western provinces reduces waste and keeps the per capita consumption down to about the same amount as in European countries. The people of Manitoba pay the highest per capita rate for their water—$6.27 per year, while those of New Brunswick come next with a per capita cost per year of $4.82.

The following table shows the estimated cost per 1,000 gallons, the estimated cost per capita, and the daily consumption per capita:—

Province.	Estimated cost per 1,000 gal. (cents)	Estimated cost per capita per year (dollars)	Daily consumption per capita (Imp. gal.)
Nova Scotia	7	3.76	147
Prince Edward Island	16.4	2.87	48
New Brunswick	8.2	4.82	161
Quebec	9.5	3.92	113
Ontario	9.6	4.21	120
Manitoba	20.6	3.46	46
Saskatchewan	23.	3.86	46
Alberta	13.	6.27	132
British Columbia	8.2	3.44	115
Canada	10	4.12	113

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3 00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **60** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, MAY 1, 1913. No. 18.

CONTENTS OF THIS ISSUE.

THE DEVELOPMENT OF FORT WILLIAM AND PORT ARTHUR.

In connection with an article in this issue on Dock Construction in Fort William and Port Arthur few people realize that these twin cities, located 1,700 miles from the Atlantic and 1,000 miles from the Pacific, and practically midway between our Atlantic and Pacific coasts, have, nevertheless, eighty per cent. of the total land area of the Dominion lying westward of them. The wealth of natural resources and the gigantic coming development of the great western portion of the Dominion are too well known to need comment here. The last harbor in Canadian territory westward of our Great Lake systems, it was the Canadian Pacific Railway, with its creation of the twin cities as a transfer point between rail and water traffic, that gave them their first hopeful outlook as an important locality. Previous to that, the route to the west was by water past Fort William and Port Arthur to Pigeon River, thence by Rainy River and Rainy Lake to Kenora. Of late years the making of Fort William into a first-class harbor and the tying up with it of the Grand Trunk Pacific and Canadian Northern Railway systems seems to assure its future in no uncertain terms.

It is doubtful whether the Hudson Bay route for the transports of the products of the West to Great Britain will ever prove as practical and feasible as some of our governments and optimistic citizens seem to think. Moreover, notwithstanding the construction of the Panama Canal and any subsequent diversion of Western traffic by that route, there must always be a tremendous traffic by rail and water between the east and west that will tax the capacity of the railways to the utmost and build up any cities which are located at the point of transfer into places of great activity. There have been signs, however, that Fort William and Port Arthur will not have to depend for their progress and importance solely on their location as the junction point of great rail and water transportation systems. It is true the transportation business at the head of the lakes requires the energy of 5,500 men, whose pay-roll amounts to over three million dollars to handle same, but important manufactures are also there. In 1912, the Canadian Car and Foundry Company started to erect a plant which guarantees to give employment to one thousand men for the first five years. Numerous other manufacturers, including the Atikokan Iron Company with a blast furnace of 200 tons per day capacity are there located. In great measure the citizens have to be grateful for the presence close to their doors of three great water falls capable of developing about 145,000 horse-power and of supplying energy to consumers at a cost ranging from fifteen to twenty-five dollars per horse-power per annum. At the Kakabeka Falls, close to Port Arthur, 45,000 horse-power has already been developed, and more energy, as we stated, is within easy reach.

The twin cities of Fort William and Port Arthur and their citizens are bound to witness paralleling their own expansion more of the material signs of the growth of Western Canada than probably any other city in Ontario. The northern shores of Lake Superior, with the exception of possibilities from the opening and establishment of extensive and great mining camps, does not, as far as nature is concerned, hold out much hope for the growth and support of a busy and modern city of large population. The development of Port Arthur and Fort William into such is a welcome sight, and is another striking illustration of the attending constructive results

of modern transport and railway systems in giving impetus and opportunity for the settlement and development of civilization in localities where otherwise nature is so inhospitable as to have delayed for many long years any extensive inroad of civilized population.

THE UTILIZATION OF WASTE ROAD SPACE.

It has been very truthfully said that this is an age distinguished for its utilization of waste products. Wonderful advances have been made in this direction, and are being made every day. The utilization applies, however, more to the cities and their manufacturing industries than it does to the country's natural resources. In the partly settled regions of the country especially, one finds waste so enormous as to far offset beneficial gains in other ways.

Travelling through our Canadian forests, for instance, even where fire has not wrought havoc, one cannot help being impressed by the waste of fallen and rotting trees around, whose wood, as fuel, if obtainable to the inhabitants of the slums of nearby cities, would be a blessing and benefit. Our highway system might also be classed as a waste of considerable magnitude.

Consider country roads. The general width of a "right-of-way" is sixty-six feet. Of this sixty-six feet, the road proper, with the ditches, occupies from twelve to, say, twenty-two feet. That leaves two-thirds of our "right-of-way," or five and one-third acres per mile, unutilized in any beneficial way. In fact, in as far as many road sides are usually a mass of weeds, whose seeds are blown and carried on to neighboring farms, they might be said to be an active agent for harm to the community.

In Europe, the better roads are laid out with grass sown on each side and in many places fruit trees, whose products, handled by the Government, goes a long way towards paying for the up-keep of the roads. Very few people would consider it possible in America to ever grow fruit trees by the roadside and expect to harvest any products from same. Sad to relate, it would probably be looked upon by the travelling public of this continent as some philanthropic scheme for the easing and benefit of their gastronomic proclivities. It would still leave the problem of utilizing waste road sides in this country in some economically beneficial way unsolved. Unless, however, one can devise such means, the returning or renting (fencing off, if necessary), of unused portions of our country roads to those who will cultivate and put them to beneficial use, their ownership becomes a serious responsibility. Consider an ordinary township, divided into thirty-six sections, with a sixty-six foot road allowance between each, the road acreage amounts to 572.4 acres. If one allows twenty-two feet for actual width of ditches, etc., then there is left two-thirds of the acreage, or 382 acres, of land wasted per township. Figured out, it would probably be within facts to state that ten or twenty millions of acres will be lost as productive land to the communities of Canada and the United States if the side widths of road allowances be not utilized.

Country roads on this continent originally needed a highway allowance of sixty-six feet, mainly because, being in a forested country, it was necessary to protect travel and the roadway from falling trees, forest fires, etc. A width of sixty-six feet, with the road in the centre, under those circumstances, was very advisable. As land becomes cleared, outside the benefits of a former roadbed, one fails to see why it would not be advantageous that the roads should be constructed solely in the right or left portion of the "right-of-way." Such a course would leave a strip forty-four feet wide, which, with a single fence, might well be rentable or workable, and so reduce the cost of road maintenance itself.

It would certainly seem advisable, for the sake of providing for possible future increase in traffic, that all highway appropriations should continue to be the full sixty-six feet of width. The need, however, of highway associations seriously solving the problem of making their spare road area productive is one that will grow with age, and there appears in it a considerable and unappreciated opening to save some of the cost of road maintenance to the interested tax-payer.

EDITORIAL COMMENT.

An instance of the beneficial work being accomplished by the International Joint Commission on Waterways between the United States and Canada has lately come to hand in a decision handed out by the Commission in regard to the proposed dam to be built in the Detroit River at the head of the Livingstone Channel. This ship-channel is partly in Canadian and partly in American waters. Deepening the upper part of the channel, it was thought, would have the effect of lowering to some extent the depth of water in the river above, and to correct this a dam to Blois Blanc Island on the Canadian side was to be built. The Canadian town of Amherstburg complained that it would injure their water front, and the question was referred to the Joint International Commission. The American interests urged the necessity of the dam to safeguard the enormous traffic up and down the Detroit River, and in this regard it might be mentioned that the tonnage on the Detroit River in 1912 reached the amazing total of ninety-five million tons, or over four times the amount of tonnage passing through the Suez Canal. The value of these shipments aggregated 80 million dollars. The decision recently handed out by the Commission in regard to the dyke which the town of Amherstburg objected to, proposes to substitute a dyke on the west side, which will have practically the same effect in safeguarding navigation while it will overcome the objections of the town of Amherstburg.

The Commission has been busy all spring on many internation questions, and is to be congratulated on the splendid work it is doing.

ELECTRIFICATION OF PANAMA RAILROAD.

Now that the relocation and reconstruction of the Panama Railroad is completed surveys are being made for the transmission of power for the operation of the line by electricity. The Gatum hydro-electric plant which is under construction will supply the energy required under normal conditions, but there will also be a connection with the present steam-driven electric plant at Miraflores. The transmission voltage will be 44,00, and this potential will be stepped down at various distribution centres for running the trains, lighting the canal, and supplying the power required for operating the various machine shops, the gates, and other appliances at the dams and locks. Bridges of the customary type for carrying the cables, etc., will span the tracks, the distance between them varying from 200 ft to 300 ft., according to the local curvature conditions of the railroad.

THE CAUSE AND DETECTION OF WATER WASTE.

The property owner pays for water waste in two ways. He pays in the form of a higher tax rate, for new watersheds, reservoirs, tunnels and pumping plants which are necessary to meet the demands caused by waste, and he pays for the waste in his water bill.

People think the water supply as plentiful as the air supply. They give no more thought of water dripping from a faucet not in use than they do to the breath they exhale. They don't know that a drip 1/32 of an inch in diameter, estimated on the meter value of water, represents in a year the loss of $11.68. They let their faucets drip, let their pipes leak and give no heed. There is plenty of water.

However, as population increases, water consumption increases and water supply decreases, and more and more it becomes necessary to seek new sources of supply, to build new reservoirs. Water famine rears its ugly head. Then they recognize that water should not be wasted and that where waste continues there must be compulsory conservation. City authorities force property owners to put meters in their buildings with a view to decreasing waste by penalizing the owner for allowing waste. He pays the penalty in the form of an increase in his water bill.

Take New York City, for example. Thanks to its prodigal water waste, taxpayers must pay $260,000,000 for a new system of supply, $10,000,000 more for a tunnel to carry it from the reservoirs and the constantly mounting cost of the upkeep of the system. When the time comes for the distribution of the new supply, new pipes must be laid in the city streets, for the old pipes will be unable to withstand the pressure. Likewise, new pipes must be laid in the buildings. And the taxpayer will see the cost of the new city mains reflected in his tax bill and will give the plumber more money for putting new pipes in his building.

If New York's water supply had been properly conserved, storage reservoirs, built at a cost of $50,000,000 or $60,000,000, would have furnished a sufficient supply, even though two years passed without a rainfall.

But even with the precautions which have been taken, the waste is still going on, and it is to the interest of all taxpayers, unless they wish to give up another half billion a few years hence, to make it their individual business to see that there is no waste of water in the premises which they own or occupy.

While it is held that all property using water should be metered and that the criminal or neglectful waste will not stop until this is done, it is not the purpose to discuss that subject here. It is intended to bring home to the individual property owner or lessee the fact that he can reduce his expenses and conversely increase his dividends by paying attention to water waste. A leak in a pipe is a leak in the pocketbook.

At the present time in New York all buildings used for business purposes are metered, as are buildings above a certain height used for dwelling places. All other property pays for its water on a frontage basis, that is, the charge is based on the number of front feet in the property and the number of water closets, bathtubs, etc., served. There is no way in which the city can detect the waste of water on premises which are rated on a front-foot basis. The man who pays on a meter basis pays for the front-foot waste because the meter rate is higher. Where the service pipe or trap (the city's pipe) is an inch or more in diameter the premises are supposed to be metered.

The meter rate, $1 per thousand cubic feet, averages much higher than the frontage rate, but despite this, proper supervision will make the water bill of the average metered property lower than that of the overage front-foot premises. The average consumption of water in a metered apartment house containing one or two water closets and bath, is 1,500 cubic feet per month per family. This does not include, of course, water used by the house plant for boiler, steam or refrigerating purposes. In a metered tenement house where there are no baths and water is used principally for domestic purposes and toilets the consumption will average 500 cubic feet per month.

In premises used for mercantile purposes the average consumption is difficult to determine, varying with the industry pursued. The same condition obtains in hotels and office buildings by reason of the fact that the occupancy of the rooms and the number of people in them are constantly changing.

In unmetered apartment houses there is a waste, on the average, of fifty per cent. of the supply sent through the pipes. This is due to negligence in caring for plumbing fixtures and delay in repairing leaks. The waste caused by leaks in water closets in unmetered apartment houses averages from 14,000 to 20,000 cubic feet a month, or a monetary loss, on a meter basis, of from $14 to $20. Underground leaks, overflowing roof tanks and the carelessness of tenants who leave taps running are additional contributors to the volume of waste. Some property owners assert that it is cheaper to let the water waste than it is to pay the plumber's bill. Although they may not realize it, these property owners are paying for the waste in their tax bills, but is it just to those who are paying the higher meter rate that they should also be compelled to pay for the waste caused by the owner who, in his ignorance and greed, says, "Oh, let it run, it doesn't cost me anything?"

Unless there is a marked increase from month to month in his bill the average owner of metered property is content to pay and take no steps to ascertain if he is getting what he is paying for. Or, perhaps, there is a small increase in his bill for a certain month. He pays no attention to it. The next month there is a still larger increase and he calls a plumber to investigate. The plumber finds a leak. But the owner must pay for the water he has not used. If this owner had in his employ an expert supervisor who knew what amount of water should be used, who could read the meter registerings intelligently and detect leaks before they became a charge on the property, the value of his services would soon become apparent in the decreased cost of maintenance.

An instance is known of a bill for $900 for water used in seven months in a seven-story metered apartment house, sheltering twenty-one families and including a store. Investigation revealed a leak due to a defective valve in an underground pipe on the house side of the meter. After the valve had been replaced by a new one the water bill for six months' consumption was $320. Since that time the total yearly bill has been $740.

In a factory building where the consumption was nearly 33,000 cubic feet per month the owner erected a roof tank to give a better supply to the upper floors. The consumption at once jumped to 110,000 cubic feet a month. The plumber neglected to put a ball float in the tank and the result was that the extra pressure at night, due to the fact that the supply was not being used, caused the tank to overflow. When the overflow and the cause were revealed the proper steps were taken to remedy them, and in the next three months the consumption dropped to 33,000 cubic feet per

month. The services of the expert cost $20 or $30. The owner saved $77 and guaranteed himself against continuing to pay for water which he did not use.

In a certain hotel the water was used for refrigeration in twelve ice boxes. The consumption was between 150,000 and 190,000 cubic feet per month. The owner called an expert who told him something was wrong somewhere and that a thorough investigation should be made. The owner took no action. but the meter did and the water bills continued to grow. Finally he ordered the investigation. The expert found that water in a 2-inch overflow was running directly into a sewer. It couldn't do anything else by reason of the construction of the ice machine. A new machine put the consumption where it should be. How did the expert know something was wrong? Because he knew that in the adjoining building, also used as a hotel, a larger building containing more rooms and occupants, and therefore using rightfully more water than its neighbor, the consumption was only 150,000 cubic feet a month in the coldest weather, and in the summer as low as 115,000 cubic feet.

In a certain downtown office building, having an engine room equipment of the highest efficiency, water bills were found to be increasing regularly for the supply used on the upper stories. At the beginning of the expert's investigation the consumption was 15,000 cubic feet a day. He found that a number of toilets on these floors were leaking steadily day after day. His recommendations for the repairing of fixtures were carried out and the consumption dropped to between 7,000 and 9,000 cubic feet a day.

Note that in the instances cited the owner is paying $1 for every thousand cubic feet of water wasted; also saving $1 on every thousand cubic feet not wasted.

In another large office building there is a restaurant on the ground floor. The lessee put in an ice machine which was consuming apparently, when the expert was called in to explain why the water bill was so large, 395,000 cubic feet per month. The expert found that the ice machine from 7 p.m. to 6 a.m. was throwing water into a tank which overflowed. The expert showed a method by which this water could be utilized for other purposes than refrigeration and the waste stopped, and at the end of thirty days the consumption had been reduced to 135,000 gallons, the lessee was getting greater service from less water and had reduced his bills by $260 a month.

The owner of a tenement house having outside water closets found his water bills increasing steadily. He called in the expert, who found that defective hoppers, anti-freezing toilets and fixtures in a bad state of repair and general neglect were causing a large waste. In one closet showing a defective hopper the water was running into the ground through a hole in a sewer pipe. The meter was registering 35,000 cubic feet per month. After the proper repairs had been made the registration was from 1,500 to 2,000 cubic feet per month.

In the average metered business building experience has shown that water closets will waste, on an average from 14,000 to 19,000 cubic feet per month. In a prominent restaurant the water consumption had been between 9,000 and 10,000 cubic feet per month. A leak in a toilet jumped this consumption to 39,000 cubic feet in a month. When it was repaired the consumption returned to the first figure.

The causes of waste are many, and only an expert who is constantly meeting with their variations can determine their exact nature. In a large bread manufacturing plant the consumption, without apparent cause, leaped from 285,000 cubic feet a month to 587,000 cubic feet. The expert called to investigate found that while there were several points of waste the bulk of it was due to the forming of vegetation on an outside condenser used for refrigeration. The growth prevented the water from exercising its normal cooling power on the apparatus, so that more water had to be used to achieve the result that had formerly been brought about with a smaller quantity. The recommendations of the expert were carried out and the consumption reduced to about 200,000 cubic feet per month.

The examples herewith cited, all of which are taken from actual records, amply show that the average property owner or lessee is making a good investment in engaging a competent individual or firm to inspect his water supply plant throughout the year; to take full charge of water bills and make repairs to fixtures or pipes whenever they become necessary. The owner or lessee seldom has the knowledge and experience necessary to enable him to ascertain the one or more causes which produce water waste, even if he could spare the time demanded for a thorough investigation. The owner, as a rule, must rely on his agent to detect and correct conditions which cause waste. The agent, for the most part, depends on the superintendent, the engineer or the janitor of the premises, and no one of these three is usually sufficiently versed in the knowledge and experience, without which he will seek in vain for an explanation of why the owner is called upon to pay for more water than he is using.

A most striking example of how difficult it is to locate some leaks, and how thoroughly all means of determination must be employed to get at the truth, is shown by the following instance:—

In a manufacturing plant situated beside the water front a certain meter began to register a large increase in the amount of water used. The owner told the expert that there had been no actual increase in his consumption. A test of the meter, which was one of several, some of them being connected, showed that it was registering properly. In other words, the amount of water it registered was passing through the pipes. All the other meters and pipes were tested, but the instruments failed to record a leak. Yet the expert felt sure there must be one somewhere. He told the owner to shut off all the water. This was done, but the meter in question continued in operation, still registering a flow at the rate of 31,000 cubic feet a month. All water had been shut off, but here was water running There was only one thing to do—lay bare every bit of pipe connected to that meter. When the diggers had completed their work, a leak was found on the under side of the pipe. The water was spurting into the river without giving any sign of a leak.

STEEL FOUNDED RAILWAY CROSSING.

In most cases it is difficult to maintain a track efficiently at grade crossings owing to the tendency of the traffic to shift the crossings out of position and to crush the ballast that supports it. An interesting development in this connection is the use of steel longitudinal members to carry the rails at the crossing, connected so as to form a unit structure and to maintain the rails in the proper position. This system has been applied to a grade crossing at Muncie, Ind., where a singe track electric interurban railway crosses two parallel main tracks of the Cleveland, Cincinnati, Chicago, and St. Louis Railway on a curve having a radius of 17-07 ft. The daily traffic averages 64 electric cars and 18 steam trains. Each rail is carried on two 6-in. channels spaced 16 in. apart, and laid longitudinally with the flanges outward, connected at the bottom by 4 in. by 5-16 in. straps 2 ft. apart, and at the top by a continuous 5-16 in. plate 20 in. wide.

NORTHERN ATLANTIC SHIPPING

Hon. J. D. Hazen, (minister of marine and fisheries), replying to a question in the house of commons, remarked that the Imperial Board of Trade, had concluded arrangements for reporting the location and the movements of ice along the route of trans-Atlantic steamships during the spring months. This announcement is one of very great importance to shipping interests. The Titanic disaster of last spring and the subsequent inquiry respecting it made the desirability of this step abundantly clear. For this purpose the Scotia was despatched on the 8th instant to latitude 44° north, longitude 60° west, with instructions to report on the way any ice met and also to endeavor to note its southern limit. After having done so, the Scotia will proceed to St. John, Newfoundland, noting and reporting ice conditions met with. While at St. John, the Scotia will get into communication with all wireless stations on the Newfoundland, Labrador and Canadian coasts, and as accurately as possible ascertain existing conditions and the direction in which the ice has commenced to move. From St. John, the patrol boat will proceed to and report the southern limit of the drifting ice. Having located and reported the southern limit, the patrol will be northward to report icebergs or field ice along the coast of Newfoundland, and as far as Hamilton inlet.

The patrol is specially charged to be vigilant in the observance of ice nearing the steamship routes. The chief object of the expedition is to give warning to the steamship lines of the probable quantity of ice that will be in the vicinity of the track, and to give them any information that will assist them to form a judgment as to the advisability of giving any instructions for the greater safety of their vessels. On board the Scotia there are three scientists, the senior of whom will direct the movements of the vessel. They will take observations of the directions, velocity and depth of currents, together with the temperature and salinity of the water. In addition, meteorological observations of the upper air, including the investigation of the currents and temperature, will also be carefully taken. Acting in conjunction with the board of trade, I have concluded an arrangement whereby all messages from the patrol boat will be forwarded to the signal office at Quebec and from there promptly furnished to all interested parties. In this way the shipping interests at all the river St. Lawrence and Atlantic ports will be kept informed of the prevailing ice conditions.

To supplement the work done by the Scotia under the direction of the board of trade, I have made arrangements whereby the Marine and Fisheries Department will, immediately after the opening of navigation on the River St. Lawrence, despatch the C.G.S. Montcalm to patrol Cabot strait, at the entrance to the gulf, from Sydney harbor to the south coast of Newfoundland.

The location and movements of the ice in this region will be reported and full information will be furnished daily, or more frequently if found necessary, to the steamship companies. I have also arranged that Professor H. T. Barnes, of McGill University, who has, during the past several years, conducted experiments on one of the departmental steamers, shall be on board the Montcalm while performing this patrol service in Cabot strait. By means of his invention, the microthermometer, Professor Barnes has demonstrated the possibility of determining the approach to ice by any vessel equipped with his apparatus. Eager to avail myself of any scheme that promises to further safeguard navigation to the River St. Lawrence, I have directed that Professor Barnes, with a staff of assistants, shall join the ship in order to further demonstrate the utility of the invention, and with a view to its general adoption by shipping interests.

THE USEFULNESS OF COUNTY ENGINEERS.

The economic need of highways has been recognized on every hand, but the provision of a workable method for building them is not so easy to pass judgment upon. In the March issue of The Iowa Engineer Mr. F. R. White and Mr. J. H. Ames, assistant engineers of the Iowa Highway Commission, discuss under a heading "Is a County Engineer Necessary?" the need and advantages of county work which has an engineer at the head of it. A portion of this paper is abstracted and published below.

As a basis of comparison, let us consider the mileage of some of our largest railway systems to the mileage of our state public highways. The Chicago & Northwestern Railway has 9,700 miles of track, and the Chicago, Milwaukee & St. Paul Railway has 8,000 miles of track, or either of these great systems has less than one tenth of the mileage that Iowa has in her public highways. Going a little farther, we find that the ten largest railway systems in the United States have a combined mileage of 103,000 or an amount approximately equal to the miles of public roads of this state.

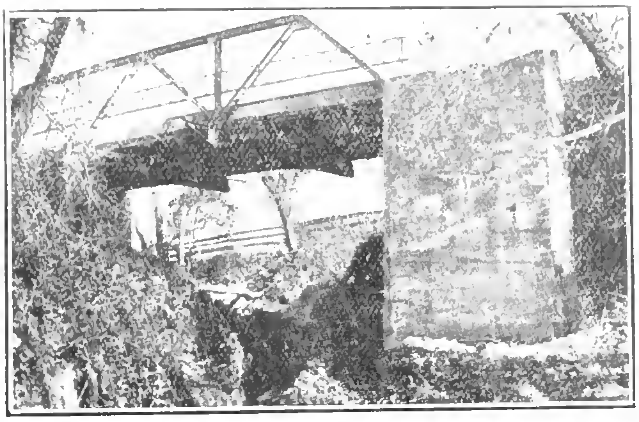


Fig. 1.—This 40-ft. Steel Span on 20-ft. Abutments has a Drainage Area of Only 69 Acres. Cost $5,187.

Of highways, perhaps not more than fifteen per cent. are what might be called "main travelled" roads. In improving our highways these main travelled roads will necessarily be the first to be given consideration. When we consider the amount of money to be spent upon this primary system of highways in order to properly provide for the present and anticipated future traffic, we are astounded at the enormity of the undertaking. In the average county in the state the cost of grading, draining, and gravelling the roads will amount to about $2,500 per mile. The cost of improving the 15,300 miles of such roads will be about $38,250,000 or an average of $386,500 per county. This includes only the "main travelled" roads, and does not take account of the amounts which the townships will spend on the township road systems.

No accurate statistics are available regarding the number of the bridges in Iowa. Adair county in the southwest part of the state has 4,200 bridges, of which over 2,000 are twenty-foot span or above. The majority of these 4,200 bridges are of more or less temporary nature and will require attention soon. Polk county has 930 bridges with an average span of 34 feet. Seven hundred and fifty of these bridges are at the present time either wood or steel, and are in very bad condition. This county has spent over $300,000 in the construction of 265 concrete structures which have an average span of 10.5 feet.

From the statistics available it appears that the average county has approximately 1,600 bridges. The average cost

of replacing these structures with permanent work as shown above will be about $1,000 per bridge, or the total cost for building all the bridges of permanent construction will amount to $1,600,000 per county, or for the ninety-nine counties in the state the cost of permanent bridges will be about $158,400,000.

The state has expended in the past year, approximately $7,500,000 on roads and bridges; an average of $76,000 for each county. The proportionate expenditure for roads or for bridges cannot be accurately determined, but the bridge fund for the majority of the counties is close to $30,000 per year. In addition to that, the townships spend a large amount of their road fund on culvert work so that the funds as now spent are about equally divided between roads and bridges.

Any railway operating on sound business principles would have an efficient organization to superintend the expenditure of any considerable amount of money. They would demand complete plans and specifications and records which would show itemized statements concerning every dollar spent. No money would be paid out of the treasury until it could be shown to the board of directors that it was a legitimate expense. To secure these results they would employ an efficient engineering organization to make the surveys, establish the grades, write specifications, draw the plans, superintend construction and keep the construction records clear and straight.

Fig. 2.—A Good Example of Improper Location and Excessive Length of Wing Wall.

Let us compare such an organization with the one in vogue in many of the counties of the state. It is a fact that the majority of the money spent on road work last year was expended without a plan or profile on file to show where or how the money was to be used.

Last season, one county confined the attention of their elevating grader crew to a short strip of road, possibly three miles in length. This work was in a hilly country where much cutting and filling was necessary, yet no survey was ever made of the road. When the work was completed, the superintendent was unable to tell the total yardage of material moved, or what the cost for moving the material had been per cubic yard. Had plans been prepared for this work and accurate cost data kept it would have been particularly valuable to the county in estimating future work under similar conditions. Most of the grading work has been done in such a manner as to provide insufficient surface drainage. Roads are graded and well crowned, yet the side ditch drainage has been incomplete. The water is allowed to collect in low places in the ditches and stand there until it evaporates or soaks into the roadway.

An example of absolute waste of money came to our attention recently. The board of supervisors, together with a number of interested taxpayers, attempted to construct a gravel road approximately nine miles in length. This road was located on low land with little surface drainage. Gravel was hauled upon this road and dumped so as to give a depth of ten inches. No provision was made for either sub-surface or surface drainage. The road was not even crowned before the gravel was placed. Such violation of engineering principles are costly experiments to the taxpayers, and show gross neglect or incompetence on the part of the supervising official.

The loss of money has not been confined to roads alone; investigations show that a very great loss has occurred in the bridge fund. Much of this loss is directly due to the yearly contract system which has been in vogue in many of the counties of the state. Under this system bridge contracts are let in blanket form. They call for no specific number of bridges and no specific location for any bridges bid upon, and as a result, the general design and the location of the structure in the field is left to the supervisor and bridge company's foreman. When such a contract is let, it is impossible to have detailed plans for the various bridges. Where any plans at all are submitted with the bids, such plans are incomplete, and will not fit the varying conditions of the different locations. Consequently when any bridge is built, there is item after item of extra charge for work not called for in the contract. Such charges, for work not covered by the contract, often run the price of the completed work up to a figure far in excess of what the work is worth, or what it might appear from the contract that the total price would be.

As an example of this, the following bill rendered by a bridge company for repairing an old 60 feet steel span is a good illustration.

To building 2 concrete abutments 12 feet deep and encasing old piers:

Building 1 (10-ft. 6-in.) wing, one 11-ft. 6-in., one 25-ft. 9-inch, and one 11-ft. 6-in. wing........	$2,935.00
Driving 11 steel piles at $7.00 each...............	77.00
Lowering old bridge 4 feet and cutting off old cylinders	160.00
Filling north and south sides, including removal of old approaches	184.00
Laying floor and hauling lumber and freight on same to Follett's	36.00
Steel joists for 60-ft. span at $5.50 per ft.	330.00
Lattice railing on span	96.00
Angle to reinforce floor beams for holding joists and drilling floor beams	74.00
	$3,882.00

This bridge after being repaired was yet an old, flimsy, steel bridge with wooden floor, and will have to be replaced in a few years. Under the same contract the county could have built a new 60-foot riveted steel bridge with concrete floor for $3,830.00 or an amount of $52.00 less than the price paid, and this price ($3,830.00) could have been reduced several hundred dollars if a competent engineer had been employed by the county, before letting the contract, to plan and superintend the work.

These specific examples are only a few of the many which occur each year under the present system. It is the direct result of the hit and miss methods of road construction that are costing the counties thousands of dollars annually. We are trying to build roads with only a part of an organi-

zation. We have the "Board of Directors" but have no adequate engineering organization.

Bridges must not be built too small to provide sufficient waterway for passing the run-off from the watershed above them, and in the interest of economy neither should they be made too large.

An example of the result of providing a waterway too small is known. The structure was a 50-foot arch bridge built in 1910. The cost to the county was about $3,000.00. Two years later, or in 1912, the structure collapsed during a freshet, and after the water had gone down it was found that the current had widened the channel by cutting behind the west abutment. As this was a patented type bridge which used the earth pressure behind the abutments to help support the arch, and which has shallow foundations as one of its characteristic features, the result of washing out the fill was the collapse of the structure.

As an example of building bridges too large for the demands of the drainage area, the bridge shown in Fig. 1 is a good illustration. Here a forty-foot riveted steel span with concrete floor and concrete abutments eighteen feet high was placed over a stream having a total drainage area of sixty-nine acres. This bridge cost the county $5,187, when the run-off from the watershed could have been carried by a 4-ft. x 4-ft. box culvert costing about $500. The county in which the bridge is located has an approximate area of 440,000 acres, and at the rate shown above it would cost $32,700,000 to bridge the entire county. The bridge fund in this county is about $30,000 per year, or at the above rate it would require the entire bridge fund for 1,100 years to get once over the county with so-called permanent bridges.

Under the systems usually used in the counties, the general design and the location of the structures are left to the supervisors and to the bridge company's foreman. The majority of supervisors are not trained bridge men, and the bridge company's foreman is not working for the county. As a result there are many examples of improper locations and designs. Bridges are often located several feet above the proper position. In a number of cases we have found concrete bridges located high upon the bank at one side of the stream, and with the pavement or floor six or ten feet above the stream bed. In other cases bridges are so located as to require excessive length of wing walls. In one case, a forty-foot span steel bridge with concrete abutments and three wing walls cost $2,925. This bridge was so located that the other wing wall was made 50 feet long, and the price paid for this wing was $2,262, or an amount nearly as great as the cost of the remainder of the bridge. Another bridge in the same county has one wing wall 80 feet long. This wing extended out into the field, and does not hold up any fill or serve any other purpose which would justify the expenditure of so much money.

In most cases, no estimates are prepared showing the labor and material required to build a given piece of work and when the work is completed the bill presented is allowed by the board without question. This is well illustrated by the record in one county where bills amounting to $57,000 and covering a whole year's work were allowed by the board at one session which lasted not more than three hours. Apparently none of these bills were checked against the structures built as evidenced by the following:—

One of the bills contained the item—

"Building concrete abutments and 2 wings, $737.10."

Investigation disclosed the fact that only one abutment had been built, and that it contained only 15.91 cubic yards of concrete, or the price paid was $46.33 per cubic yard. Another bill for construction on the bridge shown in Fig. 3, contained the item,

"One-half contract price for building concrete bulkheads 16 ft. x 20 ft. long on 48-in. steel culvert 36 ft. long $780.00

The bridge is located on the line between two counties and hence the bill was presumably approved by two boards of supervisors. The bill apparently included only the building of the concrete bulkheads.

Investigation showed that the two bulkheads contained only 15.45 cubic yards of concrete or the price paid was at the rate of $50.48 per cubic yard. According to the engineer who made these investigations, a fair cost for the concrete in each of these jobs would be $12.50 per cubic yard. Another example of the loose system under which the bridge business is handled in many counties is shown by the following invoice:

To one 14-ft. span with 12-ft. foundations.........	$ 720.00
Less acct. abutments 8 ft. deep 8 ft. at $9.00	72.00
	$ 648.00
Lattice railing	$ 28.00
One 16-ft. wing, one 10-ft. and two 8-ft. wings.....	382.00
	$1,058.00

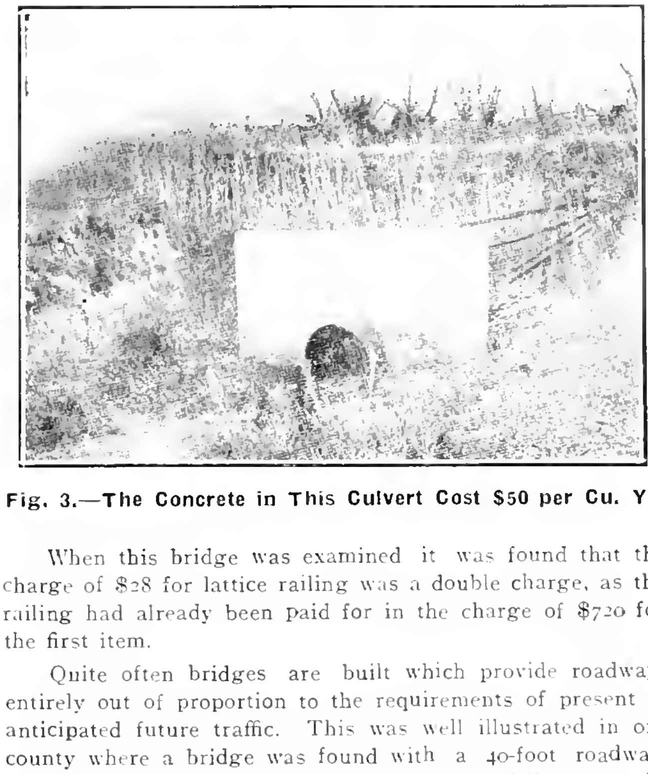


Fig. 3.—The Concrete in This Culvert Cost $50 per Cu. Yd.

When this bridge was examined it was found that the charge of $28 for lattice railing was a double charge, as the railing had already been paid for in the charge of $720 for the first item.

Quite often bridges are built which provide roadways entirely out of proportion to the requirements of present or anticipated future traffic. This was well illustrated in one county where a bridge was found with a 40-foot roadway. The location was such that an addition of filling over the culvert at some future date was impractical. The fact that the bridge was upon a road seldom frequented made this width of roadway very excessive. Not a mile from this bridge, on an adjacent road with a great deal more traffic was another bridge with an available roadway of less than twelve feet. Had a study been made of present and future traffic conditions on these structures, they would never have been built as we found them.

Frequently it is possible to relocate a road and thus avoid building one or more bridges. The following is given as a typical example. In one of the counties, a new road about three-quarters of a mile long was established in such a location that two forty-foot bridges, costing over $2,000 each, were required, when, by a slight relocation of this road, such as any engineer would make, both of these bridges

could have been avoided at a saving of nearly $4,000 and a better road secured.

In some of the counties we have found conditions for which the county boards alone are responsible, yet, in the majority of cases the state is a partner with the county boards in the mismanagement of our highway funds, owing to the fact that inadequate laws and an insufficient organization have been provided for handling the work. Road building is a business and not a side issue to the management of a large farm, or extensive business enterprise. It is hardly fair to a farmer or business man to elect him to the office of county supervisor where he has the spending of thousands of dollars annually in a kind of work with which he is not familiar, and then not provide him with the assistance of men trained in that particular line.

Before we can expect to secure the best results from the money spent on our public roads, we must provide an efficient engineering organization to work with our board of supervisors. We must give our county supervisors the assistance of the technical training and years' of experience which go to make a finished road engineer.

Fig. 4.—Not the Result of a Flood but Lack of Proper Pile Driving.

The legislature recognized this fact when, in 1910, it passed the bill creating the present State Highway Commission. The appropriation for carrying on the work was, however, pitiably small, and although increases in the appropriation have been made from time to time, yet the demands for assistance from the commission have increased at a much faster rate than have the appropriations, and the commission is at present unable to carry on the work properly on account of a lack of funds.

One of the most difficult parts of the work of the commission has been to get the bridge and road work constructed in the field exactly as shown on the plans. In the majority of cases the work has been constructed without any adequate inspection or engineering supervision in the field. At times, carefully prepared plans have been practically ignored, and in one instance a very inferior arch bridge was built from carefully prepared plans for a flat-top bridge.

To properly handle the work and prevent such miscarriage of plans as shown above, each county should employ a highway engineer whose duties would be:—

To survey the roads and prepare profiles and estimates giving proper attention to drainage, traffic, surfacing, etc.

To relocate roads so as to avoid expensive bridges and excessive cuts and fills.

To prepare detailed plans, specifications and estimates for each bridge built.

To survey the drainage areas and plan the bridges with due consideration to the waterway required.

To inspect the work frequently and see that it is done according to the plans and specifications.

To keep a complete and accurate record of the amount and locations of the work done.

Such an engineer working in connection with the State Highway Commission would complete the organization and would render invaluable service to the cause of "good roads."

DISTRIBUTING SYSTEM OF NEW YORK'S WATER SUPPLY.

The waters of the new aqueduct which is being constructed from the Catskill Mountains to New York, will empty into the Hill View Reservoir before their final plunge into the heart of the city.

The problem of admitting so large a flood into the metropolis is no small one, particularly when the chief demand for the water will come from those sections of Greater New York which lie many miles away. For the present, at least, little if any of the Catskill water will be used in Manhattan and the Bronx, but most of it will be consumed by the boroughs of Brooklyn, Queens, and Richmond. The water waste campaign which has been carried on for the past few years has so far reduced the consumption of water that the Croton system, which can furnish steadily 350,000,000 gallons of water per day, can easily take care of the immediate wants of Manhattan and the Bronx as well as the demand from these two boroughs for many years to come. It is not likely that the population in Manhattan will increase much unless it undergoes a marked vertical growth, for now there are practically no more vacant lots to be built upon. So that in estimating the future demands upon the Croton system we must consider chiefly the growth of population in the Bronx. In the other three boroughs of the city, however, there is a present demand for water and the probability of large increases in population in coming years.

To conduct the Catskill water into Brooklyn and Queens, it was decided to build a trunk line, so far beneath the surface that there would always be 150 feet of good solid rock for the roof of the tunnel, and provide a course for a subterranean river which could be tapped as needed for the city's supply, and which, at the same time, would be so completely buried that it would never menace the safety of structures above it. When this tunnel is completed it will be one of the most durable pieces of work ever constructed by man; for practically nothing but an earthquake can destroy it; and even this possibility is very remote, for the rock underlying New York is of very early formation and not at all liable to seismic disturbance. And so the city tunnel of the Catskill aqueduct is being bored through the rock on the average of 200 to 250 feet below the surface except in places where the nature of the rock is of such a character as to call for a much greater depth.

The first dip takes place just above the Harlem River, where the tunnel drops down 362 feet below the ground level. Then it runs practically horizontally until it passes the dip in the rock under 125th Street. Thence it rises again and maintains a practically constant level of 200 feet under the city, until it arrives at the ancient bed of the East River. A glance at the map of New York city will show that the East River makes a decided turn about the lower east side or "heel" of Manhattan. In pre-glacial times, the East River had no elbow in its course, but ran directly across the heel of Manhattan, and it wore away the rock in its bed to considerable depths. However, the large deposits of earth

and rock carried by the glaciers caused the river to be pushed eastward out of its normal channel and over the solid rock beyond. When borings were made for the aqueduct through this section of the city, it was found necessary to lay it at a depth of about 750 feet below the surface. Much of the rock through this section is decayed and unfit to form the walls of a high-pressure aqueduct which is being built to last for all time. The present channel of the East River, on the other hand, passes over solid rock, and is comparatively very shallow. Seven hundred and fifty feet is an enormous depth, second only to the great siphon under the Hudson River, which is 1,114 feet below the river surface. It so happens that the deepest shaft ever sunk in New York city equals the height of the tallest building in the world.

Arrived in Brooklyn, the aqueduct rises again to within two or three hundred feet of the surface, and is pushed as far as it is possible to carry it in solid rock and yet communicate with the surface. This limit was found to be at the junction of Flatbush and Third Avenues. Here it was necessary to go through 215 feet of overlying earth before coming to the rock. The caisson method had to be resorted to and the caisson was sunk over 100 feet below the water line before rock was reached. Considerable difficulty was here experienced in sinking the shaft to the rock, because it called for the use of pneumatic pressure that taxed the endurance of the workmen to the limit. From here on the water will be conducted through pipes laid in a trench of a moderate depth below the surface. From the foot of Seventy-ninth Street, Bay Ridge, the conduit will be run across the Narrows to Staten Island, through a pipe 36 inches in diameter, provided with flexible joints, and laid in a submarine trench. The details of this section of the work have not yet been given out. However, tests have been made to discover at what depth the pipe line under the water must be buried. It is evident that it must lie far enough below ground to prevent its being entangled with anchors from large vessels that may have to anchor in the Narrows. The matter has been thoroughly investigated, and practical tests have been made by dragging anchors of large size along the bottom. It has been determined that if the pipe line is buried at least eight feet under the bed, it will be entirely safe. On the Staten Island side a 48-inch pipe will carry the water on up the hill and through a tunnel into Silver Lake reservoir, 120 miles from the source in the Catskills.

The greatest interest in this city section of the aqueduct attaches naturally to that part which is being excavated through solid rock under the busy city. It is a surprising fact that a work of such magnitude can be carried on directly under our feet without inconveniencing us in the least. The only surface evidence of the deep rock tunneling is to be found at the various shafts which are located in parks, or public squares. The principal difficulty that presented itself at first was the question of storing explosives for a work of such great proportion. To keep the necessary explosives on the surface was to harbor constant menaces to the lives of the citizens. The matter was finally solved by placing the dynamite magazines far under the surface in the rock, and setting the doors to these magazines so they will automatically close in case of an explosion and trap the hot and poisonous fumes in the rock chamber, where they can do no harm to the workmen. The idea was borrowed from European practice, where mining operations are conducted close to and sometimes directly under large cities. Access to the dynamite chamber is had through a zigzag drift. At each turn of the drift a pocket is excavated, and the chamber itself is made of large capacity. In this chamber the dynamite is stored under a protecting roof to keep off any fragments of rocks that might fall when jarred by the "shooting" in the tunnel. At the entrance of the [illegible] a very substantial concrete bulkhead is built, and in [illegible] a low doorway. The door is of massive construction, built of I-beams, sixteen inches deep and spaced apart with oak beams twelve inches square. The door has beveled edges, so that it will seat itself snugly in the doorway. The door is always kept open at an angle of about 45 degrees. In the magazine a thousand pounds of dynamite may be kept at a time. Should this be exploded, the explosion wave would have to travel down the zigzag passage and would lose much of its force at each abrupt turn, finally striking the door with greatly diminished energy. The door would be slammed shut by the blast of air issuing from the drift and would then be held shut by the gases of the exploded dynamite. A magazine of this sort has been constructed near the foot of each shaft—not at the foot, however, for fear that in case of a mishap, it might block the escape of the men. The magazines have been tested by exploding a number of sticks of dynamite around the first bend in the drift, and in every case the door has closed just as expected.

The work through the rock is being pushed very rapidly; at some of the shafts between 800 and 1,000 pounds of dynamite have been used daily. Within the last year millions of pounds of dynamite have been exploded under the city, while most of New York was totally oblivious to the fact. Already a number of the tunnel sections have been "holed" through. To expedite the work, one contractor is using an interesting form of shoveling machine, built especially for this work, so that it may be taken down the comparatively narrow shaft and be assembled to work within the small diameter of eleven feet, which is the size of the tunnel at the particular point where this machine is now being used. The machine is controlled by a single operator, and does the work of six laborers.

Some of the work on the city pressure tunnel has been hurried so far that certain sections are now being lined with concrete. The forms used for this purpose are very interesting. They cover 120 feet altogether and are arranged in two sections, sixty feet of the lower half of the tunnel being concreted in an advance of sixty feet of the upper part. The first step is to lay the "invert," that is, a narrow segment of the lining running along the bottom of the tunnel. This, when completed, forms the track upon which the forms for the rest of the lining travel. The forms are mounted on trucks with wheels tapered to fit the curve of the invert. The forms for the lower half cylinder are practically the same as those for the upper half cylinder. After the lining has set, the sides of the upper form may be drawn in to free them from the concrete, by operating the turnbuckles A, and those of the lower forms by operating the turnbuckle B. Then jacks may be unscrewed to lower the upper section slightly freeing it completely from the concrete and jacks E may be screwed up to raise the bottom section slightly upon the truck. In this collapsed condition the forms may be drawn forward to complete the next section of tunnel. It is quite a different task, however, to lay the concrete into the upper form. Sections of the plating of the upper forms are removed and the concrete is shoveled in, adding the plates step by step as necessary, until finally the topmost plate is added when the concrete can be introduced only from the end of the form. It will be observed that small pieces of board are temporarily nailed against the edge of the forms and fitted up as neatly as possible against the rock above, so as to retain the concrete until it sets. As each section is completed, grouting holes are left in the top through which, when the lining is completed otherwise, grout will be forced under high pressure to fill up all cracks and crevices and make the lining perfectly sound.

At each shaft access will be had to the tunnel through risers or vertical pipes, 48 or 72 inches in diameter. At most of the shafts two such pipes will be provided, each fitted with valves at the bottom which may be operated from the surface to close either of them when it is desired to gain access to them or to effect any necessary repairs. The valves at the bottom of the risers will be of such a design as to close automatically in case of an abnormal flow through the risers, due to the destruction of the valve at the top by explosion or other accident. At the top of the risers there will be two valves, the one nearer the riser being an emergency valve, which may be closed in case of any damage to the other valve.

It is probable that no immediate changes will be made in the water supply of Manhattan and Bronx, except that pipe lines will be run from the shafts to help out the existing supply in case of emergency. In Brooklyn and Queens, where thirty-five pumping stations are now required, most of the stations will be discontinued for the reason that the water will be delivered through the aqueduct at sufficient pressure to reach all parts. Only in one or two sections will pumping be necessary.

From Hill View reservoir the water will flow through a tunnel, 15 feet in diameter. This will be narrowed to 14, 13, 12 and 11 feet; which is the diameter of the rock tunnel at Fort Green Park, Brooklyn, and at the intersection of Flatbush and Third Avenues. From there on steel pipes, five and one-half feet in diameter and running down to four feet in diameter, will carry the water to the Narrows, and under New York Bay, at the Narrows, the line will be only three feet in diameter. This gradual shrinking of the aqueduct reminds one of those large rivers that flow out of the mountains in sufficient volume to be navigable and even a menace to the surrounding country in time of flood, but which, when they reach the deserts are drunk up by the thirsty sands and sucked by the torrid sun until they vanish without any clearly defined terminus or possibly flow in a sickly stream to a small stagnant lagoon. Thus, when the entire Catskill system is completed and operating at its full capacity, the waters which three days before poured out of the Ashokan reservoir in a mighty flood, over seventeen feet in diameter, will reach Staten Island, a stream only 3 per cent. of its former size, after having been robbed by the rest of the thirsty city.

LIMITATIONS OF BITUMINOUS CARPET SURFACES.*

By A. W. Dean, M. Am. Soc. C. E.†

A bituminous carpet surface is well defined as "a bituminous surface of appreciable thickness formed on top of a road crust by the application of one or more coats of bituminous material, with gravel, sand or stone chips added." Such a carpet is not formed by the use of oil emulsions, consequently, emulsions will not be considered in this discussion, nor will a crust approximating two inches in thickness be considered, inasmuch as when a coat or blanket is made of such thickness, it ceases to become a carpet, but rather becomes an integral part of the road crust or pavement.

Limitations in the use of bituminous carpet surfaces are governed by three principal features. First, character of the road crust under the carpet. Second, character of the carpet itself, including both the bitumen and the grit or such material as is applied with the bitumen. Third, character of traffic to be sustained. Taking these in their order named, let us first consider the character of the crust.

This should be of such a nature and on such foundation that the weight of the traffic will be thoroughly sustained without any aid whatever from the carpet. For average traffic on suburban roads, a water bound macadam road on a suitable and sufficient foundation is an ideal crust upon which to apply a bituminous carpet, regardless of the nature of the bitumen used to form the carpet. Under some conditions, a cement concrete crust is excellent and preferable to water bound macadam, in that it has more stability and will withstand a greater load. A concrete crust, however, does not appear to hold a carpet of an asphaltic nature as well as it holds one formed by the use of tar, the adhesion being apparently less with the former than with the latter material. A crust of good gravel, thoroughly compacted, is good under restricted traffic conditions, but it does not appear to hold a carpet formed by the use of heavy asphaltic or tar binders, unless the carpet is made of such thickness that it becomes a part of the road crust. Heavy binders as referred to herein are intended to mean binders that require heating to a temperature of at least 180 deg. F. in order to permit satisfactory application. A bituminous carpet on a gravel road appears to be successful under comparatively light traffic if a bitumen is used that does not require heating to a temperature above 100 deg. F. before application.

A carpet formed by the use of any material on a dirt road is of no value whatever, as it breaks up under any kind of traffic and very soon ceases to be a carpet.

Continuing to the second principal feature, namely, the character of the bituminous carpet, we have again a very important factor. The kind of bitumen used and the method under which it is applied, the kind and amount of grit used, and the character of the grit, each and all have a very decided influence on the limitations of economical use. Experience has shown that a carpet must be uniform in thickness, and in order to be so the bitumen and grit must each be spread uniformly, and in order to spread the bitumen uniformly experience has shown that it must be distributed by means of pressure applied in some manner, either by introducing air or steam pressure directly into the tank in which the bitumen is contained, or in securing pressure by means of a pump of some form. Experience has demonstrated also that where it is desired to make a carpet requiring the bitumen to be applied at the rate of ½ gal. per sq. yd., uniformity is more successfully obtained by applying the bitumen in successive layers of approximately ¼ gal. per sq. yd., each layer of bitumen being covered with grit before the succeeding layer is applied.

The grit used for covering the bitumen should contain no clay or loam, and if the traffic to be borne is a mixed traffic, with steel tires predominating, it appears that the best and most lasting results are obtained by using a mixture of coarse and fine material, the coarse material consisting of tough pebbles, or stone broken to pebble size (approximately ½ in. in diameter), mixed with material of a finer nature, such as sand or a coarse grade of stone dust. Such mixing is better accomplished if the two grades of grit are applied separately in forming the blanket, that is, the coarser material being applied first and immediately followed by the finer material. Such method of application appears to give a firmer carpet that will withstand a greater amount of steel tire traffic than will a carpet formed by the use of either coarse or fine material alone. If a car-

*Paper presented before the American Association for the advancement of Science, Cleveland, Ohio.

†Chief Engineer, Massachusetts Highway Commission.

pet is to carry a traffic consisting largely of automobiles, the coarser material does not become as necessary, although it appears to be preferable.

The kind of bituminous material that it is preferable to use in a carpet is still a debatable subject, particularly as to whether tar or asphalt products are preferable, and in the use of asphalts, whether a heavy asphalt requiring high temperature (200 deg. F. or more) before application is preferable to one that does not require such high temperature. It has been the experience and observation of the writer, however, that the asphalts requiring high temperature before application give better and more permanent results under a mixed traffic than do the lighter asphalts. By mixed traffic, the writer means a combination of trucks, automobiles and heavy and light horse-drawn vehicles. A carpet formed with a heavy asphaltic material, however, does not withstand traffic consisting largely of heavy steel tired vehicles, the effect of such being to cut the blanket and cause it to crumble and to soon disappear from the surface.

The third principal feature, namely, the character of traffic, must necessarily be considered in connection with the second principal feature, already discussed. In fact, neither one of these three features hereinbefore mentiond can be discussed entirely by itself, as each is dependent somewhat upon the others. With a suitable road crust to sustain a bituminous carpet, traffic is an extremely important factor in determining what type of materials to use for such a carpet. The amount, type and weight of vehicles must necessarily be considered. It has been demonstrated that a tar carpet will carry economically 100 automobiles per day per foot in width of roadway, together with a horse-drawn traffic of 15 vehicles per day per foot in width of roadway. On the other hand, a similar tar carpet failed under a traffic consisting of 20 heavy, horse-drawn, steel tired vehicles per foot in width of roadway per day, with only 8 automobiles per foot. This clearly demonstrates that a tar blanket is not suitable and should never be used to sustain heavy horse-drawn traffic, but is suitable and economical in carrying automobile traffic. Inasmuch as no particular wear appeared to be caused by the above mentioned automobile traffic, it is safe to assume that a much larger traffic could be economically carried. Records kept by the writer show that what has been stated above regarding the tar carpet is true also of the heavy asphaltic oil carpet. Failures that have occurred under the writer's observation with a heavy asphaltic oil carpet have occurred where the ratio of the number of automobiles to the number of horse-drawn vehicles was not any greater than two to one, and if the horse-drawn vehicles are of the heavy two-horse type, with narrow tyres, no amount of automobile traffic appears to be sufficient to counterbalance the destructive effect of 15 heavy horse-drawn vehicles per foot in width per day.

The writer is of the opinion that it is not wise at the present time to state general positive conclusions regarding limitations in the use of bituminous carpet surfaces. Such surfaces have been in use in this country only about four years, and the character and quality of the bitumen used at various times and in various places are so unequal, and the character of traffic over the highways is and has been changing so rapidly, that the results of experiments and observations have been variable. Positive and definite conclusions as to limitations can be drawn only after careful observation through a period of years, keeping a record of the kind and quality and amounts of material used in the carpet, and of the kinds, number and approximate weights of vehicles passing over the sections under observation.

THE ELECTRIFICATION OF TUNNELS.

With the announcement of the construction of several large tunnels by the different steam railways in the West, and the general electrification of tunnels in New York, etc., it is perhaps not out of place to recall and briefly describe the one large tunnel in use in Canada which, originally built for steam-operated trains, was electrolized and so operated in 1908, and has continued to give splendid satisfaction as such ever since.

The St. Clair tunnel under the St. Clair River, and connecting Sarnia, Ont., Canada, with Port Huron, Mich., United States of America, is more than two miles in length, including its approaches. The length of the tunnel proper is 6,025 feet, and the length of electric trackage, including yards, is approximately 12 miles. The tunnel has a maximum grade of two per cent., and was built under the St. Clair River by the Grand Trunk Railway under the supervision of Mr. Joseph Hobson, the chief engineer; Mr. T. E. Hillman, first assistant engineer, and Mr. M. S. Blacklock, second assistant engineer. It was constructed in order to overcome the obstacles presented by a navigable stream, alive with commerce during the summer, and often blocked by ice in winter, and previous to its opening the Grand Trunk Railway freighted the trains across the river by means of car-ferries. The tunnel is a continuous iron tube, nineteen feet ten inches in diameter, the total weight of iron being 56,000,000 pounds. Work was commenced in 1888, and the tunnel was opened for freight traffic in October, 1891, and passenger traffic in December of the same year. The cost was $2,700,000.

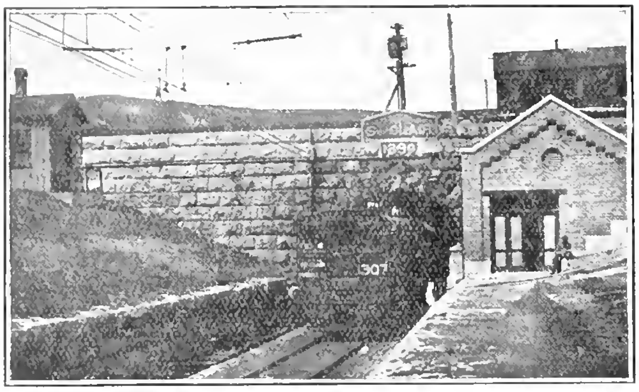
Western Portal of Tunnel.

Shortly after the opening of the tunnel for freight traffic the need of some method of doing away with the noxious and injurious gases, which formed from the smoke of the steam engines, was at once obvious. The natural remedy was the use of electric locomotives, and after mature deliberation, the Grand Trunk decided in favor of operating the tunnel by electricity. The power plant was located on the Port Huron bank of the St. Clair River and the length of zone electrified was four miles. The single-phase system was adopted, and the single catenary supported by structural steel bridges was the structural method used; the normal voltage being 3,300 volts. The Westinghouse Company finished the contract in May, 1908, and the cost was $600,000.

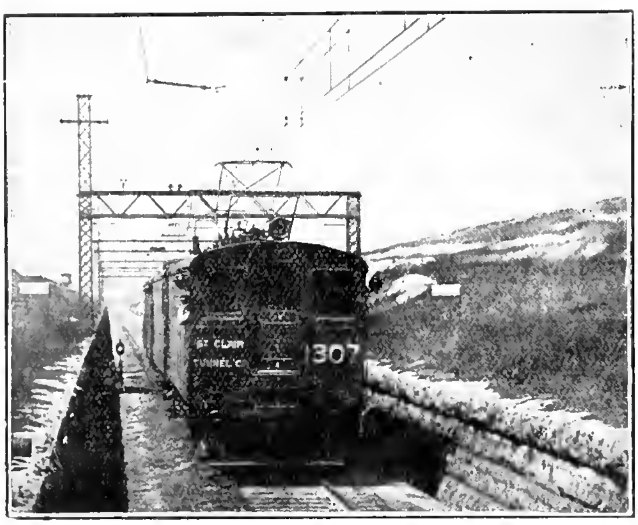
A comparison of the haulage before and after electrification is also interesting. The normal weight of trains hauled through the tunnel before electrification was 760 tons; after electrification it was 1,500 tons. The weight of the steam engines formerly used, which, when built, were the largest

in the world, was 200,000 pounds; the weight of the two electrical engines in use is 270,000 pounds each. The electrical engines have a normal motor capacity of 1,500 horsepower and a normal draw-bar pull of 50,000 pounds. A maximum speed of 35 miles per hour, and a minimum speed of 10 miles an hour up a two per cent. grade with a 1,000-ton train.

The tunnel has been a paying proposition, as the train service now operated through the St. Clair tunnel is very heavy. It is now lighted throughout, and presents the appearance of a well-lighted street instead of a tunnel sunk underneath a river, where the annual tonnage of vessels passing through is about twice as great as that passing through the Suez Canal.



Entrance to Eastern Portal.



Approach Crade and Engine.

In comparing the tunnel before and after electrification, one soon arrives at the conclusion that the correct method of operating a tunnel of any length is by electricity, as the evil-smelling and damp tunnel of before cannot be compared with the well-lighted, dry, and novel appearing passageway which the St. Clair tunnel now presents.

It is expected that New York's state barge canal will be ready as a whole in 1915. Locks are being built for 3,000-ton barges. An important percentage of the state's population lives within twenty miles of the canal on either side, and the motor truck will give farmers and manufacturers easy access.

THE INTERNATIONAL WATERWAYS COMMISSION.

In regard to the work now being carried on by the International Water Commission, Mr. L. J. Burpea recently stated that three important questions were being investigated by the commission.

The first of these relates to the levels of the Lake of the Woods and its tributary waters. This to some may seem a comparatively small matter, but in reality it involves very large interests, as far apart as Winnipeg and Duluth. The investigation is the outcome of complaints as to damage to lands along these waterways by flooding. The farming communities would like the level of the lake lowered. On the other hand, navigation interests complain that the water in the lake and its connecting rivers is already too low for their purposes. There are the fishing and lumbering interests to be considered, and the very important interests of power development. To reach a decision which will be fair to all these interests, on both sides of the boundary, the commission cannot afford to act hastily, or without having the fullest possible information on the subject. It now has survey parties representing both countries, obtaining technical data upon which it may base its conclusions. It has already held hearings at International Falls and Warroad on the American, and at Kenora on the Canadian side, at which everyone interested in the question, from any point of view, was given full opportunity to present his views. With this evidence and the engineering data, the commission will be in a position to recommend to the Canadian and American governments a solution of what has become a very intricate and troublesome problem.

The second question that the commission is investigating, and in which connection it recently held a meeting in Detroit, is the building of a dam in the Detroit River, in connection with the Livingstone Channel. This dam is intended to be built partly in Canadian waters, and is designed to protect the interests of navigation. At the Detroit hearing, however, a considerable difference of opinion developed among engineers and shipmasters as to the advantages of the proposed work; the town of Amherstburg complained that it would injure their waterfront, and counsel on behalf of the Dominion Government argued that one of the principal objects of the dam (to raise the level of the water) would be nullified by the unauthorized diversion of water at Chicago for the drainage canal, that a simpler and cheaper remedy would be to prevent this diversion, and that it would be preferable to deal with the dam, not as an isolated work, but a part and parcel of a comprehensive scheme of development of all these international waters for the benefit of the people of both countries. On the other hand, the American interests urged the necessity of the dam to safeguard the enormous traffic up and down the Detroit River. Here, again, the commission has a difficult and intricate problem to solve, and one that must be approached with the utmost care and absolute impartiality. Incidentally the evidence brought out threw light upon the amazing development of the shipping industry on the Great Lakes, the tonnage on the Detroit River in 1912 reaching the tremendous total of 95,000,000 tons, or over four times the tonnage passing through the Suez Canal; and the value of these shipments aggregated $800,000,000.

The third question the commission is investigating on behalf of the two governments is the exceedingly important one of the pollution of boundary waters. If the commission never succeeded in accomplishing anything more than helping to safeguard Canadians and Americans living along the international boundary, it would more than justify its ex-

istence. In this great undertaking it has the hearty co-operation not only of the federal health authorities at Washington and Ottawa, but also of state and provincial boards of health on either side of the boundary. During the coming summer a thorough examination will be made by sanitary experts to ascertain the principal sources of pollution, and when this data has been collected and digested the commission will be in a position to consider the remedy or remedies best assigned to meet the situation.

In addition to these questions, referred to it by the two governments, the commission also has before it several applications involving the erection of dams and other works in boundary waters. In such questions as these, under the terms of the treaty, the decision of the commission is final. It is in effect an international court of appeal, or, as it has been described, a Hague Tribunal for America, to which everyone interested, either for or against, any project involving the use of boundary waters of navigation, power purposes, sanitary canals, or irrigation, may appeal with the assurance of a fair hearing and an impartial decision.

COAL MINE FATALITIES FOR 1912.

The coal mine accidents occuring in the United States during the year 1912 have been compiled by the United States Bureau of Mines, under the direction of Frederick W Horton.

Mr. Horton, in reviewing the year, says: "During the calendar year 1912 there were 2,360 men killed in and about the coal mines of the United States. Based on an output of 550,000,000 short tons of coal produced by 750,000 men, the death rate per 1,000 employed was 3.15, and the number of men killed for every 1,000,000 tons of coal mined was 4.29. The number of men killed was the least since 1906; the death rate per 1,000 employed was the smallest since 1899; the death rate per 1,000,000 tons of coal mined was the lowest, and the number of tons of coal produced in proportion to the number of men killed was the greatest on record. These facts offer indisputable evidence that conditions tending toward safety in coal mining are actually improving and that coal is now being mined with less danger to the miner than ever before. The general improvement in 1912, as compared with 1911, is shown by the following facts:

In 1912 the number of men killed in the coal mines of the United States was 359 less than in 1911—2,360 as compared with 2,719—a decrease of 13.2 per cent., and this in spite of the fact that there were more men employed in the mines and more coal mined than in any previous year.

The death rate per 1,000 men employed in 1912 was 3.15, as against 3.73 in the previous year, a decrease of 15.5 per cent.

During 1912 for every 1,000,000 tons of coal mined 4.29 men were killed, as compared with 5.48 men in 1911, a decrease of 21.7 per cent.

There was 233,000 tons of coal mined for each man killed in 1912, as compared with 183,000 tons in 1911, an increase of 50,000 tons, or 27.3 per cent.

Although the improvement in 1912 was greater than in any previous year for which accurate statistics are available, partly due, perhaps, to exceptionally mild weather during the last few months of the year decreasing the likelihood of disastrous coal-dust explosions, there has been an annual improvement for a number of years, as indicated by the accompanying table:—

Number of Men Killed in and About the Coal Mines of the United States in the Calendar Years 1907 to 1912, Inclusive, With Death Rates.

	— Number killed—			
Year.	Total.	Per 1,000 employed.	Per 1,000,000 short tons mined.	Production per death, short tons.
1907	3,197	4.88	6.93	144,000
1908	2,449	3.64	6.05	165,000
1909	2,668	4.00	5.79	173,000
1910	2,840	3.92	5.09	177,000
1911	2,719	3.73	5.48	183,000
1912	2,360	3.15	4.29	233,000

It will be noted from the foregoing table that the death rate per 1,000,000 tons of coal mined has decreased annually, that the production per death has increased each year since 1907, and that the death rate per 1,000 men employed has steadily decreased during the last four years.

This general improvement has been brought about by a combination of causes, the principal one of which has been more efficient and effective mine inspection on the part of the State mining departments and State mine inspectors throughout the country, supplemented by greater care on the part of both the operators and the miners. The investigative and educational work of the Bureau of Mines has kept the operator and the miner alive to the various dangers connected with coal mining and has shown what precautions should be taken to avoid these dangers. The bureau is, therefore, gratified with the improvement shown, particularly as the greatest improvement relates to dangers concerning which the bureau has been conducting special investigations, as is shown later. The bureau, however, can not too strongly express its appreciation of the co-operation of the State mining officials and the operators in the work of making coal mining safer.

Although there has been an annual improvement in mine-safety conditions since 1907, and a particularly notable one in 1912, a still greater decrease in the death rate can be effected. Whether or not such an improvement will be made in 1913 depends largely on the care exercised by the operators, superintendents foremen, and all others in authority, and by the miners as well, to prevent the rise of dangerous conditions and to avoid unnecessary risks when such conditions have arisen.

The R.M.S. "Kyle," which is being built and engined at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, to the order of the Reid Newfoundland Co., of St. John's, Newfoundland, was recently successfully launched. The steamer is intended for the mail and passenger service between Newfoundland and Labrador coast, and is exceptionally strongly constructed for running the ice which she will frequently meet on service. She is 220 ft. in length by 32 ft. beam and will be rigged as a two masted schooner. She is to be fitted with accommodation amidships for 68 first-class passengers, including dining saloon with seating accommodation for 32, ladies' room, smoking room, etc., and there will be a good promenade deck for the passengers' use. Aft there is to be accommodation for second class passengers, 102 men and 40 women, and there are two hospitals, one for men and one for women in a deckhouse above. There will be a complete installation of electric light, including searchlight, efficient arrangement of steam heating suitable for the climate, and wireless telegraphy will also be fitted. The steamer will be propelled by single screw triple expansion engines.

COAST TO COAST.

Toronto, Ont.—The Niagara park commission is completing arrangements for the granting of a concession to a Spanish company for the installing of an aerial tramway over the whirlpool. The tramway will be about a third of a mile long and will cross from one Canadian shore to the other, greatly lessening the distance which is now covered by the International Railway which runs around the whirlpool. The immensity of the undertaking may be appreciated when it is considered that the pool must be spanned by a single cable with no support beyond the towers and anchors at each end, and that at the same time this cable must be sufficiently strong to carry the cars and passengers.

Toronto, Ont.—John Gott, chief electrical engineer of the Commercial Cable Company, has invented a device by which the Morse dot and dash signals can be used on long submarine cables, and by which a message was sent recently from Toronto to London, Eng., direct without relaying; that is, the message was sent by the ordinary land line Morse key and read on a Morse sounder. Lord Kelvin invented the first instrument to decipher signals, and it was called the Thomson reflecting galvonometer, or what is commonly known as the "mirror." The great objection to the "mirror" was that no permanent record of the message was sent, the reader calling off the message to an assistant as it was reflected. Sir William Thomson then invented the siphon recorder, which overcame the difficulty of not providing a record. In the siphon recorder a light coil of wire is suspended in the field of a powerful magnet, and the movements of the coil in response to the current through the cable are recorded on a narrow paper tape passed in front of a fine glass siphon attached by silk fibres to the suspended coil and dipping into an ink-well. The end of the siphon traces in ink a line on the tape, and this line goes up and down in response to the movements of the coil from side to side in response to a change in the polarity of the current. When a point of the line rises up above a fixed point it means a dot and a valley is a dash. Only practice can enable a man to read accurately and quickly a message by the siphon record. The technical details of the Gott invention are not being told at present, but the same voltage as at present used is required, and it is said that very little new machinery is needed. One feature of the Gott system is a delicate instrument which magnifies the faint note of the far-travelling dot and dash, and increases the volume of sound into a loud click. It is quite probable in the opinion of electricians that by Mr. Gott's invention it will be possible to transmit through automatic repeaters telegraph signals around the world, and the time will be less than one second.

Victoria, B.C.—A publication of the Pacific Highway Association of North America records the creation in Oregon of a State Highway Department, whose engineer will be at the service of all county courts that may desire advice and assistance from him. A strong point is made that all money raised by bonds for road purposes must be spent along permanent lines. Statistics are given showing amounts of money expended on roads in Oregon for the last four years and the number of miles of $5,000 per mile road could have been built for the same amount. The cost of the Pacific Highway through Cowlitz county is shown at $8,542.73 for grading and bridging per mile. The concluding paragraph of the bulletin runs: "The problems for the Pacific Highway Association to solve during the next two years are many. Among the most important is the erection of the Pacific Highway sign from Redding, California, to San Diego. In Oregon and Washington the problem is to encourage the local authorities to put the Pacific Highway in as good condition as possible before the Panama Exposition in 1915. The construction of the highway in California will be taken care of by the state. During the next two years, one, and probably two, hard surfaced roads will be completed throughout that state from north to south. In British Columbia the highway will be completed by the provincial government by 1915. This year British Columbia will spend approximately $6,000,000 on roads.

Saskatoon, Sask.—The subject of an interprovincial highway across Canada is on the programme of the Union of Canadian Municipalities for its next convention at Saskatoon. In order that the enterprise may be brought with united force to the attention of the Dominion and provincial governments, municipal councils are now being asked to adopt the following form of resolutiou: "Resolved, that this council is strongly in favor of the making by, or in conjunction with, the governments concerned, an interprovincial highway, of good standard construction, across Canada. This council request the Union of Canadian Municipalities to secure united action for the purpose."

Victoria, B.C.—Following the custom of previous years, the health authorities of this city soon will start another campaign against insanitary structures and the conditions which make them a menace to the public from the viewpoint of health and fire. For some time past the sanitary inspector has been making a tour of the city with a view of listing all those premises which, in his opinion, should be demolished, and at an early session of the city council authority to start condemnation proceedings against such buildings will be sought. There are at present on the list approximately fifty buildings and sheds which come within the list of dangerous premises. A great number of these are stables in the outlying sections, the condition of which cannot be improved to meet the by-law requirements in the way of sewer connection and other sanitary arrangements. Within the past two years the policy of the city in ordering the destruction of sheds has been followed. In Chinatown the campaign was especially energetic, with the result that a great number of insanitary wooden outhouses, verandahs, fences, etc., were destroyed, and in consequence the sanitary conditions in that section materially improved. The medical health officer, Dr. G. A. B. Hall, Sanitary Inspector Lancaster, and Fire Chief Davis are the officials who are chiefly concerned in this work, and their joint report will soon be forthcoming.

Calgary, Alta.—Mr. R. A. Ross, at present acting general manager of the Toronto Hydro-Electric, in his recent report to the city on the power question, made the following recommendations: "For future extensions thereafter, if there is no change in the art in the next few years, steam turbines with gas-fired boilers will be our recommendation, in spite of the greater economy of the gas engine. Should the development of the gas engine or gas turbine or some other improvement render it possible to utilize other sources of power than that recommended there will be no difficulty in introducing it later when it is ripe. Our recommendations are as above in spite of the fact that the gas engine, from a power standpoint, is the cheapest. In combination with hydro power steam from gas-fired boilers is cheaper than hydro and gas engine up to 20,000 kilowats. The natural gas engine is hampered as follows: The great capital investment being 100 per cent. more than for steam equipment. The whole service will depend upon the integrity of a pipe line 172 miles long. The large gas engine is not in such a stage of development as yet as will insure its success in your plant, and the use of smaller units would increase the capital and operating costs considerably over those indicated

in our report. The advantages of steam as compared with gas in this case are as follows: The decreased capital cost involved. The utilization of natural gas with coal as a standby in case of failure of pipe line. The establishment of a plant in which every item has been tried out for years and in which no experimenting is necessary, and the greater probability of quick deliveries of apparatus."

Ottawa, Ont.—In regards the petitions that have been received from the landowners on a number of streets asking to have tarvia macadam streets constructed, Controller Nelson issued the following statement: "What we propose to do in these cases is to construct a more substantial roadway than the tarvia macadam as used on the Improvement Commission driveway. We propose to build up the streets of broken stone as in the case of the ordinary macadam road. Then have six inches of smaller broken stone mixed with tarvia and above this two inches of tarvia and very fine stone, covered with a layer of tarvia and dust. This, it is believed, will prove most satisfactory, making over eight inches of solid composition of broken stone and tarvia. The residents along Center Street who petitioned for an asphalt pavement last fall are now endeavoring to have it changed to this kind of roadway, which will be less expensive, not nearly as dusty, not so noisy, and does not require sprinkling. It is the intention of the works department to make several experiments in regard to the use of a simple top dressing of tarvia and dust along other streets. Last summer, on Mutchmore Street, west of Bank Street, we had the street swept and a thin coat of tarvia and dust put on. This was done only once, yet to-day, going along Mutchmore Street in this section, you will see the effect still remaining, and in places it is as smooth and hard as the top face of asphalt. We think that if this were done continuously for a number of years it would form a solid face on the street that would be as good as pavement. We are going to try it on Wurtemburg Street, from Rideau north to the end of the street; on McLeod, from Elgin to Bank Street, and on Fourth Avenue, west of Bank. This will be done out of general fund, less what will come out of the sprinkling that will be saved on these streets. The permanent tarvia macadam will be done under local improvement.

Regina, Sask.—Despite the general financial stringency, which is but slowly loosening up, building operations are in full swing in this city. The steel work has been completed now on the ten-story McCallum Hill building, and work is being rushed on putting on the tiling floors. The announcement has been made with respect to the change of plans of the Grand Trunk Pacific Railway. This company intended to erect a nine-story hotel at a cost of $1,000,000 and a two-story station. The hotel as originally designed will be erected. The station, however, will be much more elaborate. It will be a five-story structure, according to the official announcement, and it is now proposed to join the station and the hotel by means of a well-equipped underground passage. It is generally understood that the total cost will be well over $2,000,000. The Dominion Government has decided to dredge the Qu'Appelle River where it links up with the Fishing Lakes in the vicinity of Fort Qu'Appelle, and to construct three dams, which will considerably increase transportation facilities. The Provincial Government is draining the Wascana Lake in order to lay pipes for a reserve water supply for the Parliament buildings. Construction work on the street railway extensions has already been started, and at the present time there are about one hundred men at work, and in the course of the next month and a half it is expected that there will be at least four hundred employed. Altogether, $825,000 will be expended by the city on street railway work.

ELECTRIC DEVELOPMENT UNDER AN UNUSUAL HEAD OF WATER.

The Swiss, as a nation, are generally given credit for being the leaders in the design and manufacture of electric machinery designed for use under high heads of water. Word comes to hand of a power development scheme which outdoes, in the use of an available head of water of 5,412 feet, any previous development of which the writer is aware.

Mr. Boucher, of Lousanne, Switzerland, a civil engineer who has designed many other water power schemes with comparatively high heads, and who is a member of the board of the Society of the Electro Chimie, of Paris, has persuaded them to carry into execution the conversion of the water power of the Lake of Fully, near Martigny, in Canton Wallis, Switzerland, with a head of 5,412 feet, into electric energy. The execution of this project has been fully resolved upon, the work commenced, and the orders for the necessary materials placed.

The most interesting question in connection with this scheme arose when deciding in what manner the pipe line should be constructed in order to withstand a pressure of 2,425 lbs. per square inch at the lower end. However, a most satisfactory, as well as perfectly simple, solution was found.

The pipe line in a length of about 2¾ miles consists of pipes with inside diameters of 19 11/16 inches and 23⅝ inches, and thicknesses of from 15/64 inch to 1 25/32 inches. The pipes of the upper section will be of the well-known water gas lapwelded type, whereas those of the lower part will be seamless.

These seamless pipes, which are drawn in strong drawpresses from a steel ingot, and which can be made up to the largest diameters, offer as high a security as one could wish on account of their perfect homogeneity, especially for schemes of such high demands as the present.

The turbines for 15,000 horse-power will be built by the engineering firm of Piccard, Pictet & Company, Geneva. The construction of the pipe line is in the hands of Thyssen & Company, who possess at Muelheim-Ruhr extensive steel, plate, and tube works, as well as a water gas welding plant for large pipes, and where a great many pipe lines for water power plants have already been constructed.

PERSONAL.

MR. J. J. ANTONISEN, city engineer of Moose Jaw, Sask., has been appointed street railway commissioner at Brandon, Man. Mr. Antonisen is a graduate of Leipzig University and formerly divisional engineer for the Canadian Pacific Railway. Prior to going to Moose Jaw he was city engineer at Port Arthur, Ont.

MR. J. E. ASKWITH, assistant city engineer of Prince Albert, has been appointed first permanent town engineer of Redcliffe, Alta.

STANLEY H. FROME, resident engineer of the Grand Trunk Pacific Railway at Calgary, has been appointed to the staff of the city engineer of that city. Mr. Frome's work with the city will be connected with taking soundings and the construction of concrete bridges.

MR. W. W. BELL, until recently chief assistant to Major Hodgins for the construction work of the Grand Trunk Railway, has been appointed engineer for the construction of the Banff-Windmere Road.

OBITUARY.

MR. E. B. WINGATE, former city engineer of Hamilton, Ont., and one of the best known civil engineers in Canada, died recently at the age of 58 years. Deceased was a native of Philadelphia, Pa., where he received his education and was employed in the engineering department there. He planned the tunnel and bridge at the canal for the T. H. & B. Railway. He was shortly after appointed city engineer of Hamilton, from which position he resigned owing to ill-health caused by hardships suffered while engaged in railroad work in South America.

CANADIAN PUBLIC HEALTH ASSOCIATION CONGRESS.

The 3rd annual congress of the association will be held in Regina, Saskatchewan, September 18th, 19th and 20th. Local secretary, R. H. Murray, Bureau of Public Health, Regina.

Arrangements are now being made by a local committee and further information will be available in the course of a few weeks.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, P. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, P. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, May 8, 1913

Contents of this issue on page 691

The Canadian Engineer

An Engineering Weekly

FREIGHT TERMINALS AND FREIGHT HANDLING AT TERMINALS.

By J. S. BUSFIELD, B.Sc., A.C.G.I.*

The problem of designing a freight terminal and of handling the freight in the terminal is one that is becoming more and more complex, and in making a study of any one particular situation a great many controlling factors have to be taken into consideration. Difficulties are introduced owing to the requirements in one town or city being different from any other town or city, so that the company which wishes to design a terminal for a certain city has no terminal situated and operated under exactly similar conditions which it can copy, but must make an independent study of the local conditions and requirements and then gather together as much information as possible in connection with the design and operation of as many other terminals as possible. It is beyond the scope of this article to deal with a great many of the modern freight terminals, but an attempt will be made to give a general description of the requirements and the methods employed at some of the up-to-date terminals handling large quantities of L.C.L. freight.

The handling of package—L.C.L—freight at the terminal is the most expensive item in the cost of its transportation from one point to another, so that a freight terminal must be so designed as to permit of the most economical and efficient handling of freight from the wagons and drays to the freight cars, and vice-versa.

Under the economic conditions prevailing, wages are continually increasing and at the same time, it is commonly asserted, human efficiency for performing physical work is diminishing, consequently all commercial interests are working to eliminate the human element by introducing all kinds of mechanical labor-saving devices for performing the work formerly done by man, and in recent years great strides have been made in the use of machinery for handling package freight, for it has been estimated that the cost of handling a ton of freight at its starting point and destination is over 10 times the cost of transporting it 100 miles on the railway.

Location.—In making a study of the conditions controlling the design of a freight station the first thing to be taken into consideration is the location of the terminal, as this is one of the most important items which will determine whether the railway company will obtain a large share of the city's business or not. In a great many cases there is no choice, but where there is, great care should be taken to have the terminal in the centre of the shipping district—using the word shipping to include consignors and consignees—because, other conditions being equal, the shipper will send his consignments to the nearest freight house. The placing of the terminal in the heart of a business district naturally means very high prices for the necessary land, but this can often be compensated by the use of a freight house of two or more stories, in fact, this type of house is coming more and more into use, not only on account of land values, but more particularly on account of the railway tracks having to be either elevated or depressed from the natural ground surface in order to eliminate grade crossings in the busy parts of the town or city. Details of this type of house will be dealt with later.

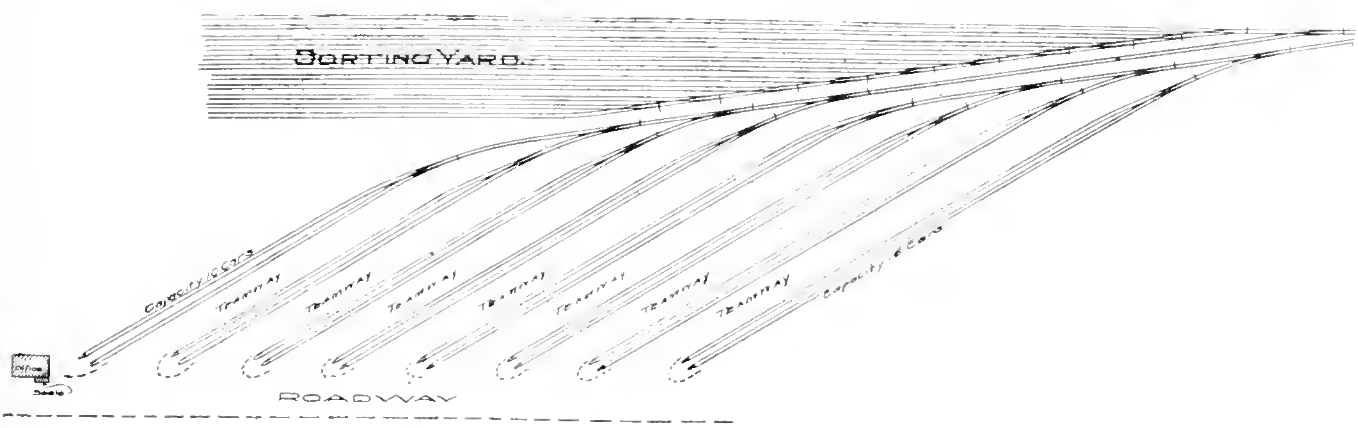


Fig. 1.—Typical Team Yard.

Layout.—Having selected the most suitable site for the freight house, and the necessary capacity decided upon, the next step is to look into the question of track layouts, storage and handling sheds and platforms, office, etc., and in doing this the capability of future extension must not be overlooked, as it is usually the best policy to acquire the necessary

* With the Montreal Tunnel and Terminal Company.

property at an early stage rather than wait until it has increased in value to prohibitive prices; and in this country of rapid growth future extensions of every kind of plant have to be properly provided for.

The general design of terminal sheds will be found to be different in almost every terminal examined, as they are always governed by such local conditions as the general topography of the surrounding neighborhood, the property limits, location of the streets in the immediate vicinity, direction of traffic, nature of the commodities to be handled, and numerous other factors.

surface or else with some standard paving block, care being taken to provide sufficient drainage facilities, as a muddy and heavy teamway is very detrimental to the business. Team tracks, as a general rule, should not be made excessively long, as this increases the cost of switching and making up the trains; the most convenient length has been found by experience to be about 400 to 600 feet in the clear, giving a car capacity of from 10 to 15 cars on each track.

For handling heavy machinery, boilers, lumber, etc., it is usual to provide one or more overhead travelling cranes. These are frequently made to span a teamway and the two

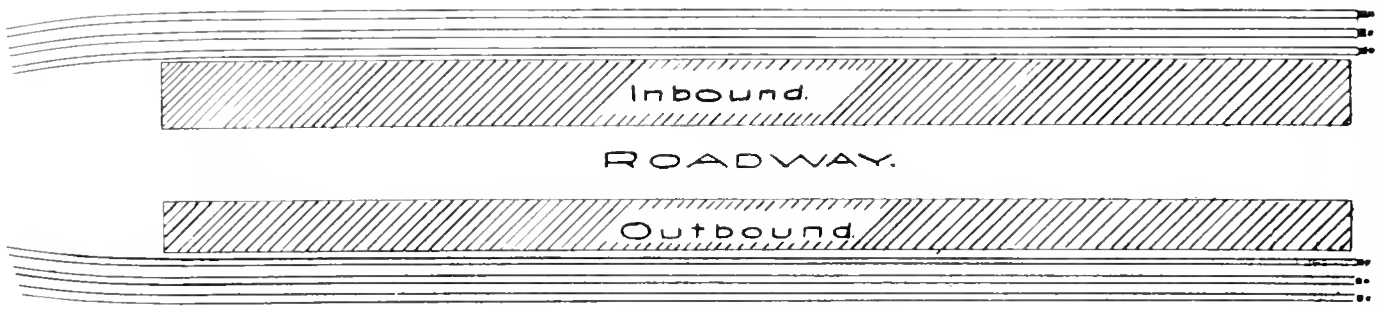


Fig. 2.—Typical Freight Shed Layout.

Mechanical Handling.—Mechanical handling of freight has not been adopted except in some of the most modern of large terminals, although various systems are being largely used at steamship piers where freight, both package and in bulk, has to be moved over longer distances and over more definite route than are obtainable in the average freight shed for handling freight from the cars to drays and storage spaces and vice versa. There are various systems, however, which are adaptable to the mixed requirements of the freight terminal, which will be described later.

Team Yards.—In addition to the freight sheds where L.C.L. freight is handled, a freight terminal is hardly complete without a team delivery yard for delivering car-load freight direct from the cars to the teams. A typical layout of a team yard is shown in Fig. 1, and this type of yard is

adjacent tracks, or the teamway and each pair of adjacent tracks, or the teamway and one pair of tracks. In fact there are numerous different ways of locating the crane which, again, may be fixed or travel on its own track in the same direction as the team tracks.

Freight Sheds.—The freight sheds most commonly encountered are those which are situated with the tracks and sheds on the same level as the roadways. In some of these one shed is used for both the inbound and outbound freight —it should perhaps be mentioned here that inbound freight refers to the freight brought in by the railway and outbound that taken out by the railway—but in other cases where a greater quantity of merchandise is handled the two sheds are kept separate, and although it is not done in every case it is distinctively advisable to have the inbound shed considerably

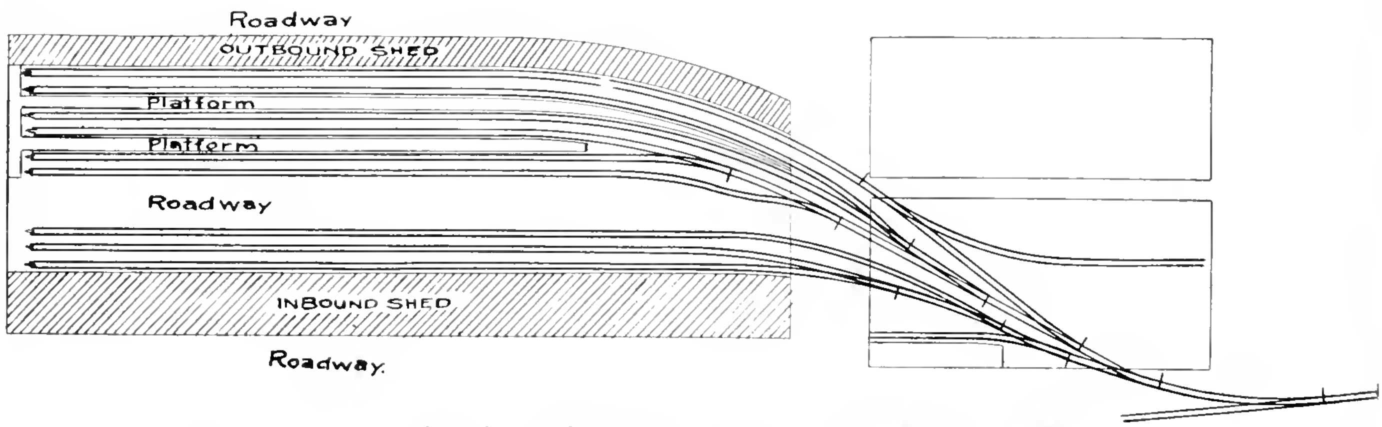


Fig. 4.—Freight Sheds and Transfer Platform, Rock Island Railway, St. Louis.

usually employed, modified in some form or other to suit the local conditions.

As will be seen in Fig. 1, the tracks are laid in pairs, with from 11 ft. 6 in. to 13 ft. centres between them. The width of the teamway is frequently made 40 ft. clear between the tracks, but in cases where a more economical layout is required and land is high priced, they can be narrowed down to 30 ft., but this latter is very apt to cause crowding and congestion, hence delays in the handling of the freight. The teamways should always be well made, either with a macadam

larger than the outbound because a fair percentage of the inbound freight has to be stored pending the arrival of the consignee's wagons to take it away, whereas in the outbound shed the merchandise deposited by the wagons can usually be taken direct to the cars. A certain quantity, however, has to be stored as frequently cars destined to certain points are only placed at the sheds on alternate days in order to insure a full load instead of shipping small loads, or having the goods transferred at some division point or transfer station.

There is a great deal of diversity of opinion with regard to the arrangement of tracks alongside the sheds, but the commonest method is to have two or three tracks on one side of the shed and have the cars spotted opposite the shed doors, with the doors of all three cars in line so that the outer one is loaded or unloaded through the other two. A general arrangement of this type of terminal is shown in Fig. 2.

This system has the great disadvantage of the costliness and danger of uncoupling, spotting and recoupling all the cars, and also of the congestion liable to happen on account of three cars all having to be worked through the one opening, but with this type of shed there is no immediate remedy, and it has its advantages which in many cases counteract the disadvantages.

Another type of freight house, differing somewhat from the general run, is that erected by the Pennsylvania Railroad at Indianapolis. (Illustrated in Fig. 3). The shed itself is L-shaped with the two portions 50 ft. x 335 ft. and 40 ft. x 180 ft. respectively. The tracks are spaced with 11 feet centres, and the intermediate platforms are 12 feet wide.

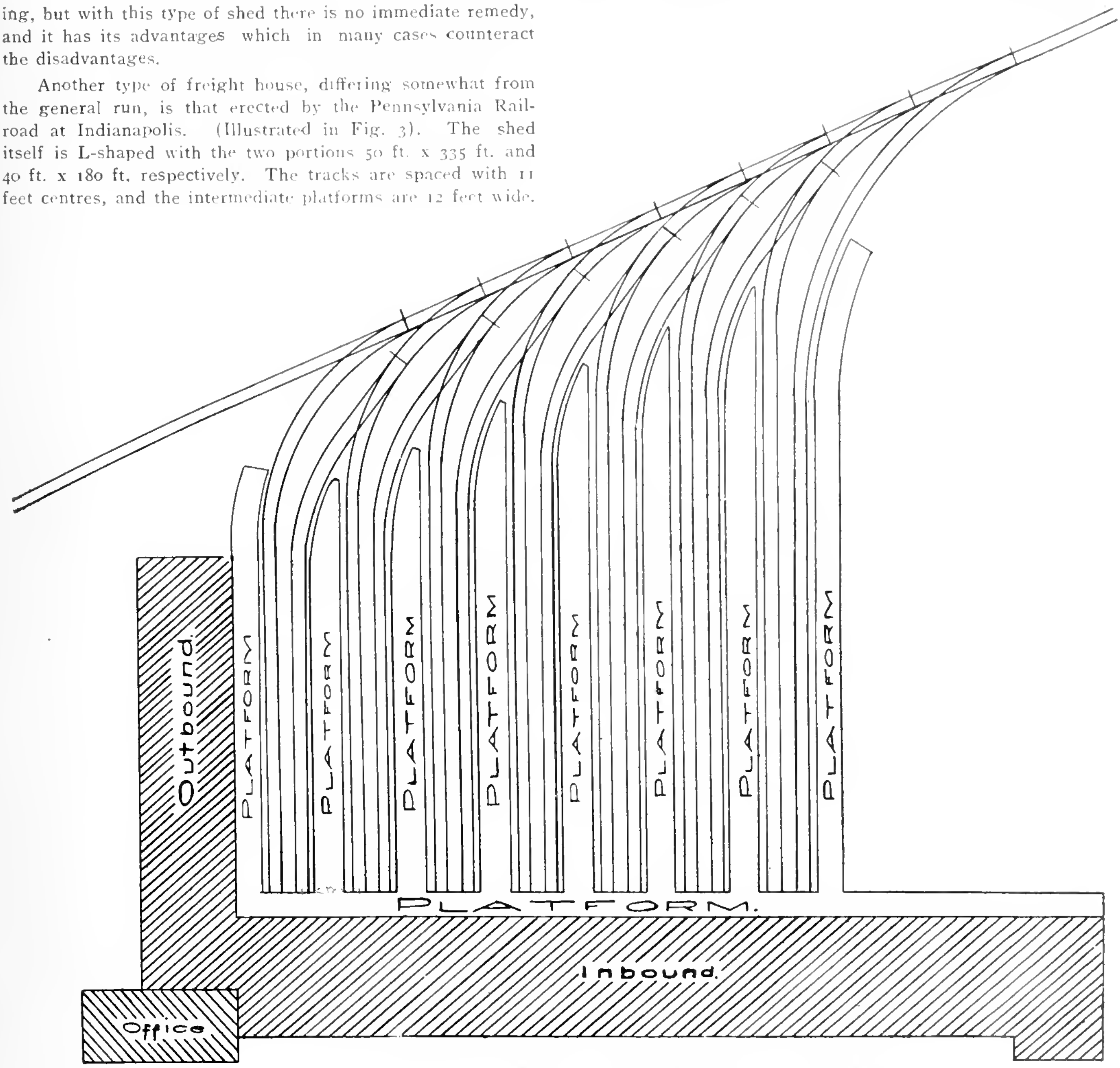


Fig. 3.—Freight Shed of Pennsylvania Railway at Indianapolis.

On account of the limits of the property the tracks are laid with curves of 100 feet radius.

Still another type of modern freight terminal is that of the Rock Island in St. Louis. A plan of this is shown in Fig. 4. The outbound house is 24 ft. x 570 ft. and the inbound house 46 ft. x 577 ft. and two 8-ft. transfer platforms are provided.

Figure 5 illustrates the freight terminal built by the Lake Shore Railway at Toledo, Ohio, and at first sight it does not look as though it could be operated very efficiently on account of the great amount of trucking required, but contrary to expectations the claim is made that the freight handled at a cost of about 35 cents per ton.

From these few examples of terminals illustrated will be seen that in general terminals on the one level may be divided into two classes, namely, those in which the in and outbound freight can be handled to and from the cars without having to switch the cars from one track to another and, second, those in which the cars, after being unloaded at the inbound shed, have to be switched to the outbound shed to be loaded. Now, as a general rule, it is fairly safe to say that it is more economical to move freight to the cars than it is to move cars to the freight, so that the former of the two classes presents the best features for economical operation, although in many cases the reduction in cost of switching is counterbalanced, or even overbalanced, by the additional

cost of handling the freight in the terminal due to the longer haul necessitated by this arrangement.

Two-Story Freight Houses.—The best way of handling freight in and outbound without having to switch the cars from one shed to another, or having a very long trucking haul is to adopt a two story freight house. This type has other good features, such as economy of land, and is readily adaptable to modern conditions which require the tracks to be elevated or depressed in order to eliminate grade crossings. It is roughly estimated that $2 per square foot will

for loading and unloading the freight from the cars. Five large high-power elevators are provided for handling the freight between the different stories.

Still another type is that of the Wisconsin Central in Minneapolis. This house is 417 feet long and varies from 66 feet 1 inch to 79 feet 7 inches wide. The tracks are below the street level, and all freight is handled on a 24-foot platform and outbound freight is brought in on a low level roadway direct to this platform, ten 6-ton scales being provided, one for each of the doorways. There are four 5-ton and one

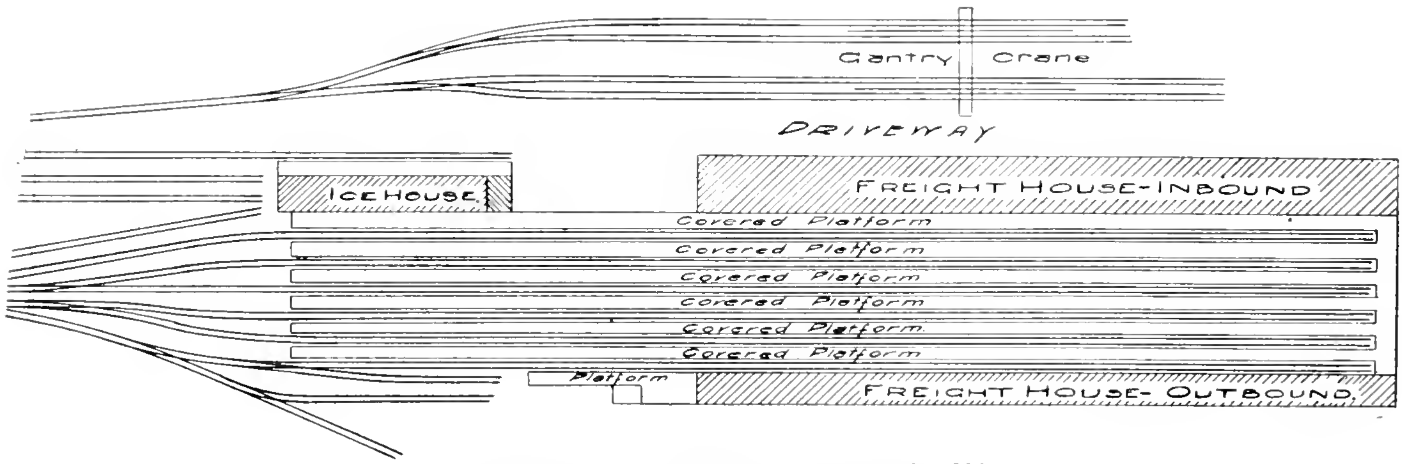


Fig. 5.—Freight Shed, Lake Shore Railway, Toledo, Ohio.

cover the additional cost of a two-story, slow-burning construction building, above the cost of a single-story building of similar construction.

A modern freight shed with four different floor levels is that of the Wabash Railroad at Pittsburgh, Pa, illustrated in Fig. 6. The tracks are on a high level, and the space between the unloading and loading platform and the teamways is occupied with storage rooms. The total width of the house is 145 feet and the length 572 feet, and it has accommodation for 50 cars, or, including storage space, 125 cars.

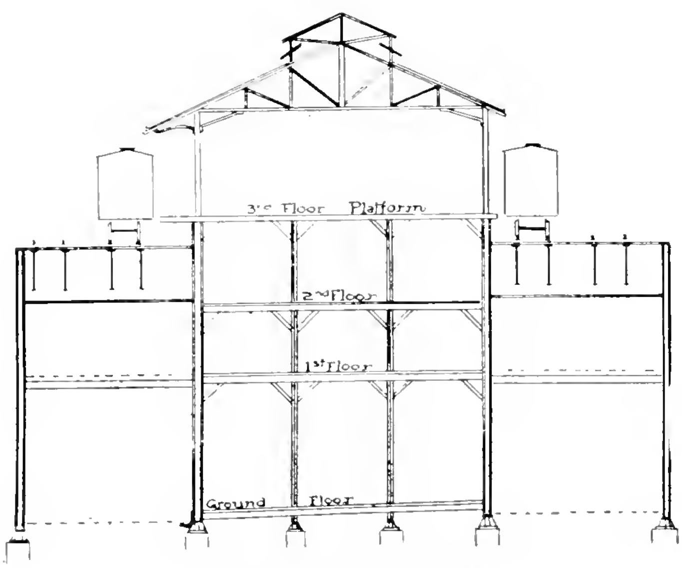


Fig. 6.—Cross Section Wabash Freight Terminal, Pittsburgh, Pa.

The ground floor is used for delivering and receiving freight and is paved with asphalt. The first and second floors are used for storage and are divided up into a number of warerooms, which are rented for the convenience of shippers. The third floor is that upon which is situated the platform

10-ton elevators for taking the inbound freight up to the street level, where it is stored or delivered to the teams. There are also two additional storage floors above this, the total storage area being 100,000 square feet.

In both these sheds the handling of the freight between the cars and teams and storage rooms is done entirely by hand trucking, but there are a number of sheds in which the freight is entirely handled by mechanical means, which will be described in connection with the mechanical handling plants.

Mechanical Handling of Freight.—At the present day there are very few plants in operation for the transference and general handling of package freight at terminals where large quantities of package freight are handled between cars and drays, but a great deal of attention has been paid to the subject within recent years, and there are quite a number of different methods from which one, or a combination of two or more, of these methods may be selected to meet the special requirements of any particular case. Quite a number of plants of different kinds have been installed at steamship piers and freight transfer stations and warehouses, but the conditions to be dealt with are usually quite different in these cases to those obtained at freight terminals for handling L.C.L. freight.

Now, before the subject can be dealt with in an intelligent way, the requirements, method of operating and all the local conditions have to be thoroughly understood. The old method of handling freight at the sheds required six operations for outbound freight and two to three for inbound, as follows:—

Outbound Freight.

(1) Checking and receipting freight at platform.
(2) Designating packages for proper cars.
(3) Moving the hand trucks to scales by one gang.
(4) Weighing.
(5) Trucking from scales to cars by another gang.
(6) Stowing in cars by third gang.

Inbound Freight.

(a)

(1) Unloading from cars.
(2) Trucking to wagons.

(b)

(1) Unloading from cars.
(2) Trucking to storage space.
(3) Trucking from storage to wagons.

In order to increase the efficiency of the working of the terminal and hence reduce the cost per ton of merchandise handled in the terminal, a mechanical freight handling plant must conform as closely as possible to the following requirements:—

(1) It must eliminate rehandling as much as possible.
(2) It must cause no congestion.
(3) It should be so designed and operated as to give a large increased capacity to the terminal compared with the old hand trucking method.
(4) The operating expenses should be reduced.
(5) The switching of cars should be reduced as much as possible.

A type of moving platform has been devised for handling freight, and is capable of development for use in a variety of cases. This platform can be used either to carry the package placed directly on the conveyer or else to move the trucks in which the freight is loaded. For use in a large freight shed two of these platforms could be placed on either side of the shed, moving in opposite directions. A great many suggestions have been made with regard to the use of these platforms, but they do not seem to have been used to any very great extent.

Some are in favor of a moving platform three to four inches above the level of the stationary platform, with short ramps, adjacent to it, while others think that the platform should be set in level with the shed floor. The relative value of these methods will probably only be settled by experience.

Another type, similar in operation to the moving platform, but different in construction, is the chain conveyer, different views of which are shown in Fig. 7. As will be seen, this is simply another means of moving the ordinary hand trucks at a fair rate of speed along fixed lines. The

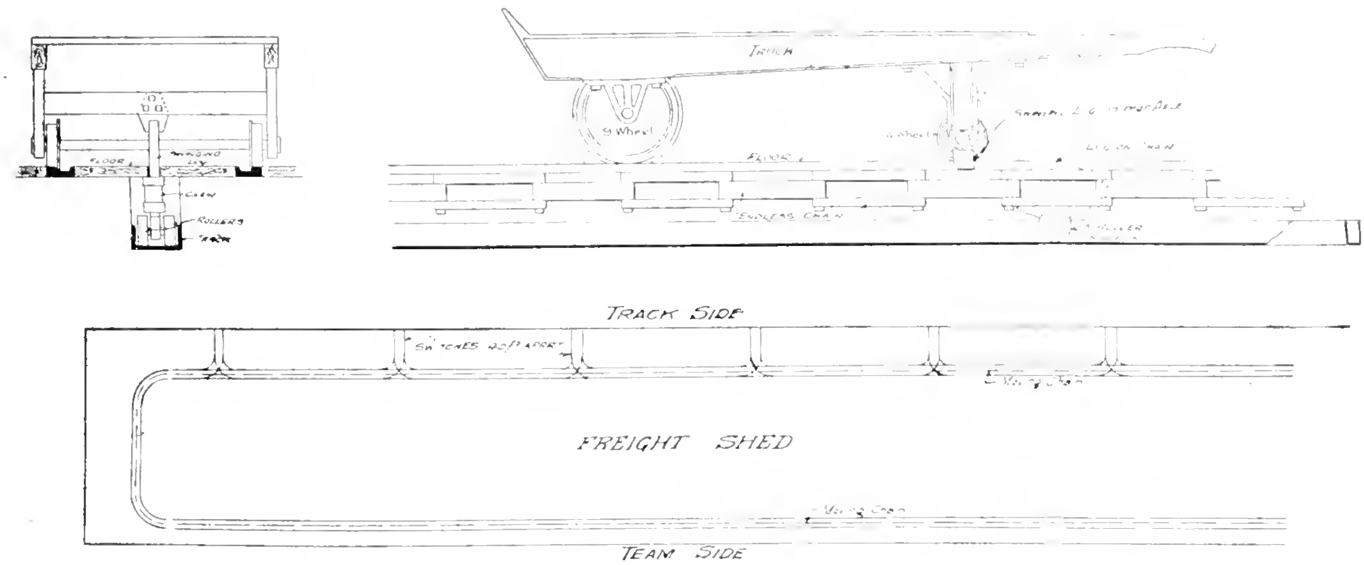


Fig. 7.—General Plan and Details of Chain Conveyer, with Truck in Position.

(6) The detention of cars in the terminal should be reduced to the minimum.
(7) It must be capable of being operated at high speed.

In general, the different kinds of plants for handling freight may be divided into four classes, viz.:—

(1) Conveyers.
(2) Overhead travelling cranes.
(3) Carrier systems.
(4) Motor trucks.

Whatever type is selected, it must be able to overcome the difficulties of coping with the great variety of shape, size and weight of commodities which it will be called upon to handle, also with the necessity of transferring the various packages from the teams to the cars, and from the cars to the storage platforms, or to the drays at the shed doors.

Conveyers.—There are quite a number of different types of conveyers in use for different purposes, such as roller, chain, belt, platforms, etc. These conveyers are very suitable for use where freight of one general class has to be handled on more or less fixed routes, such as are usual on steamship piers and transfer stations, but they are not adaptable to changing conditions.

roller chain is set in a space below the floor with an opening through the floor about one inch wide immediately over the centre of the chain. On either side of this opening running rails are set in flush with the floor, and in operation the truck is wheeled on to the track and when lined up the handle end is lowered and a swinging lug on the rear axle falls into the slot and is engaged by a lug on the chain which then pushes the car forward. Switches should be placed at about 40-foot intervals around the shed, as shown in the general plan in Fig. 7. This conveyer has been patented by a firm of conveyer manufacturers and is designed to travel at a speed of 60 feet per minute, carrying one truck every 12 feet, enabling the conveyer to handle about 100 to 150 tons per hour.

Roller gravity conveyers have been installed for special purposes, such as at the Minnesota transfer, near St. Paul, where large quantities of lumber and shingle are distributed from the cars by gravity over the lumber yard and warehouse.

The general opinion, however, with regard to these type of conveyers described above is that they are too limited in their capabilities to be really efficient in handling the great variety of package freight such as is usually met with at a general freight terminal.

Overhead Travelling Cranes.—Overhead cranes have not been installed to any very great extent for handling package freight, but they are serviceable for taking heavy and bulky loads over short distances and constant routes. They are very expensive to install, owing to the great weight of the moving parts and the heavy foundations and supports required. It has been suggested that a trucker could take his load to a crane which would then lift the truck with its load and carry it to its proper location in the house, the trucker returning to the car with the nearest empty truck, or it might be found convenient to have a narrow gauge track and car operated by hand from the track side door to the street side door. The crane could then handle this as easily as a truck.

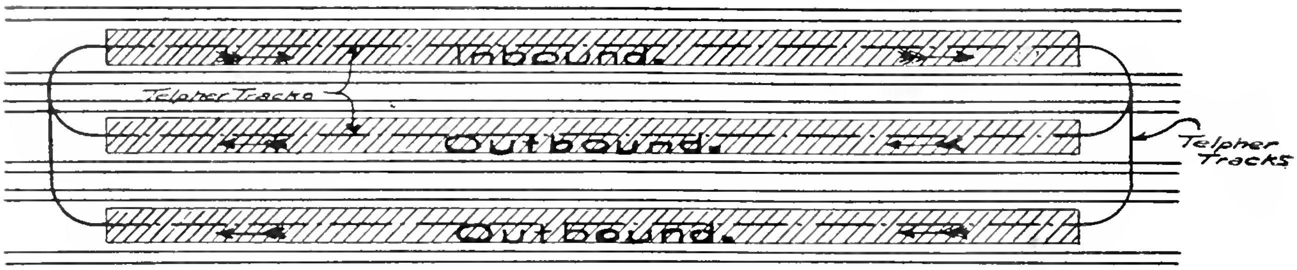


Fig. 8.—Plan Showing Telpher Tracks at Bergen, Sheds of Erie Railroad.

This scheme is as susceptible of development as that of the moving platform or chain, although the crane is liable to be more expensive both in installation and operation.

(To be continued).

THE EFFICIENCY OF COAGULATING BASINS.

Engineers who have had any experience with the operation of filter plants will find the paper recently read before the Illinois Water Supply Association by W. F. Monfort,, chemist of the St. Louis water department, both instructive and interesting. The St. Louis installation comprises a coagulant house capable of treating with lime and iron sulphate more than 160 million gallons per day with a series of unbaffled basins. There are no filters, but six basins of about 25 million gallons capacity; one of 40 million gallons, and two of 20 million gallons each. The water flows through all of them in series. The combined capacity of the system is 230 million gallons and the area about 250 acres. The system has been giving satisfaction ever since the World's Fair, but lately the suggestion has been entertained of supplementing with a filter plant the present treatment. Mr. Monfort's paper reads as follows:—

Capacity of the Plant.—It has been popularly assumed that the plant as now constituted is ample for the adequate treatment of an indefinitely large volume of water. One writer estimates the capacity of the plant at 250,000,000 gals. per day. Operating results warrant a much lower estimate based on the degree of success attained in treatment of varying quantities of different waters, ranging in suspended solids from 14 to more than 8,000 parts per million.

There is reason to believe that even in the first year of operation the clarifying system was overtaxed. The records of this laboratory afford but twelve determinations of suspended solids in river and clear well samples during the year 1904-1905, of which two must be discarded for obvious reasons. All are given in Table I. with consumption for their respective dates.

In the absence of any evidence to the contrary it is assumed that the scattered analyses are representative of the working of the plant. Treatment was begun on March 22, 1904; the first recorded result nine days later suggests the inadequacy of the plant, which then comprised but the six basins in series, to clarify 67,000,000 gals. per day when the suspended matter was 2,400 p.p.m. For 97.5 p.p.m. of suspended matter in the finished water indicates the introduction into the distribution system on the corresponding day, April 1, 1904, of 27.5 tons of suspended solids. It is possible that this result was abnormal, since mud previously deposited in conduits and clear well may have been loosened by the flow. The second result, two months later, shows improved working, but suggests that 75,000,000 gals. could not be handled properly when the suspended solids in the river exceeded 1,700 parts. According to present standards the only passable results in the first twelve months of operation are those of November 30, and April 1, 1905, when river solids were less than 1,000 parts, and the daily consumption was under 80,000,000 gals. Under other conditions the finished water contained notable amounts of solid matter. High consumption during the World's Fair period overtaxed the new clarification plant the entire summer. Still, these results show a vast improvement over conditions in the year prior to introduction of the lime-iron method, when the public was expected to make no complaint when 450 p.p.m. of suspended matter appeared in the tap water.

Table I.—Clarification Results for First Year of Operation, St. Louis Basins.

	Suspended solids.		Daily consumption in million
1904-1905.	River.	Clear well.	gallons.
April 1	2,442	97.5	67.5
May 30	1,717	25.0	74.5
June 30	3,753	32.5	87.9
July 30	1,694	43.6	95.6
August 30	800	15.0	89.8
September 30	1,268	22.0	91.1
October 31	578	12.0	81.7
November 30	376	2.0	77.3
December 31	208	10.0	71.2
January 31	181	—9.2	79.8
February 28	2,478	—4.4	73.7
April 1	990	0.0	70.4

In the second year of operation results are generally better. However, of 130 recorded determinations of suspended matter in clear well samples, 40 gave negative results. Figures given in Table II. are averages of 130 determina-

tions for river and 90 for clear well. Average daily consumption for each month is from high service pumping.

Compared with the new standard set by the previous year, these results are good. Apparently lower consumption favored better operation; although the occurrence of so many impossible results (negative quantities) makes interpretation difficult. The records show that from June to January, inclusive, high caustic alkalinity was carried in the treated water. This is perhaps the explanation of the high suspended solids recorded, which seem to indicate somewhat less than 80,000,000 gals. per day as the maximum capacity of the plant when the river was carrying 1,800 p.p.m. suspended solids.

The writer specifically disclaims any responsibility for the foregoing results of operation and analytical data. Results for subsequent years were determined under his direction and are believed to represent with a fair degree of accuracy the working of the plant. Averages are used in lieu of reciting the full detail of determination made on all save holidays. Inasmuch as total displacement of water in the entire basin system requires from 7 to 15 days, the averages by months of operation better represent the blended waters issuing from the clear wells to the distribution system. They are platted in Fig. 1, in sequence with those of 1905-1906.

The diagram shows graphically that when suspended solids in the raw water were below 1,500 p.p.m. and consumption did not exceed 75,000,000 gals. per day, the average suspended solids in the clear well water were usually not more than 1 or 2 p.p.m., increasing slightly with a rise in either river solids or consumption, and greatly with concurrent rise in both.

Table II.—Clarification Results for Second Year, St. Louis Basins.

	Average suspended solids. Parts per million.		Average daily consumption million gallons.
1905-1906.	River.	Clear well.	
April	.....	....	67.0
May	1,962	12.7	69.5
June	1,809	2.7	78.4
July	2,845	7.4	75.8
August	1,950	12.0	77.9
September	2,056	11.0	73.7
October	1,015	5.8	68.7
November	603	5.2	64.0
December	386	9.0	63.0
January	611	9.2	62.6
February	649	7.1	65.2
March	641	7.7	62.2
	1,320	8.2	69.0

It is noticeable that when pumpage was much above 75,000,000 gals. and river solids greatly exceeded 1,500 parts the quality of the treated water was seriously changed for the worse. In general, the curves of suspended matter in the treated water reflect the effect of high river solids and high consumption, following one or both in extreme cases, and illustrating the fact that these uncontrollable factors produce conditions which the present plant cannot meet. It appears that a raw water carrying not more than 1,500 parts of suspended matter can be made acceptable to the public of Saint Louis so long as consumption does not exceed 75 to 80 million gals. per day, but that the capacity of the plant varies inversely with the suspended matter.

The diagram further shows that from 1905 to 1910 consumption exceeded 75,000,000 gals. per day only in the summer and fall months, while in 1911 and [illegible] daily consumption has rarely fallen below this [illegible] time. The rise in river stage caused by rains of [illegible] spring and summer brings high average suspended solids [illegible] the raw water; for suspended solids vary with the stage. Coincident with these times of high turbidity comes the heaviest draught upon the distribution system, when lawns are to be sprinkled and the greatest waste of water occurs. It is, unfortunately, true that periods of highest turbidity are generally periods of greatest consumption.

Efficiency of Clarification.—There is abundant evidence that efficiency of clarification and bacterial reduction are conditioned by: Rate of flow through basins; amount of sludge already deposited; character and quantity of suspended solids in the raw water; temperature of water in river and basins; wind velocity and direction.

When a water properly treated is passed through the settling basins, 97 to 99 per cent. of the suspended matter is precipitated in the first basin, the percentage removal depending upon the character and quantity of solids contained, the temperature, wind velocity and direction, and the amount of sludge in the filling basin. In passing succeeding basins the remaining suspended matter undergoes a further reduction of one-half or one-sixth; corresponding to a few hundredths of 1 per cent. reckoned on suspended matter in the raw water, likewise dependent upon velocity, size of particles, wind and temperature. The major portion of clarification is, however, accomplished in the filling basin of 25,000,000 gals. working capacity. There is no provision for applying chemicals after water enters the basins. Efficiency of the plant, therefore, depends primarily upon the volume of water which can be satisfactorily clarified in the filling basin.

The weight of suspended matter in the effluent of successive basins varies with the weight of solids carried by the raw water. The percentage is approximately constant; the actual weight of solid matter remaining in the finished water is proportional to that originally present in the river water.

TABLE III.—SUSPENDED SOLIDS IN EFFLUENT OF SUCCESSIVE BASINS

	Parts per million	Per cent removal	Parts per million	Per cent removal	Parts per million.	Per cent removal.	Parts per million	Per cent removal
River	1,444	..	3,000	..	4,500	.	1,000	
Basin 1	14.0	99.01	47	98.5	9[illegible]	98.0	25	99.75
Basin 2	12.1	99.16	21	99.3	50	98.8	20	99.80
Basin 3	8.4	99.4	14	99.5	37	99.2	10	99.9
Basin 4	7.1	99.5	12	99.6	20	99.5	10	99.9
Basin 5	5.8	99.6	10	99.7	15	99.7	7	99.95
Basin 6	5.6	99.6	[illegible]	99.7	15	99.7	5	99.95
Basin 7		..			..	.	5	99.95
Basin 8		.				.	5	99.95
Pumpage	70		80		50		120 million gal.	

The results in Table III. are from the records of periods when pumping was constant. Since the course of currents will vary with changing rates, and the velocity and consequent carrying powers of currents increases with increase in pumping, the weight of suspended matter carried over the first weir is subject to wide fluctuations. A change in pumping from a rate of 60 to 90 million gallons per day has increased the suspended matter in the treated water (clear well) by from 2 to 7 p.p.m., and a further sudden increase to 120,000,000 gals. per day has caused a further rise of 10 to 13 parts, which was carried through the entire series of basins and conduits to the clear well, where 25 to 30 parts of solids in suspension occurred.

Slight changes in temperature suffice to alter the course of currents through the basins. In the spring, when the temperature of water in the river and basins is rising, the sludge is less subject to disturbance than in the fall and early winter, when, with falling temperature, the influent water, more dense than the warmer water of the basins, passes downward over the sludge, causing it to carry over weirs.

In the fall, with lowering atmospheric temperatures, the sludge and water in the bottom of the basins are sometimes 1 degree Fahrenheit or more warmer than surface water of basins and river. Circulation is then effective in changing the course of influent water currents, making them deeper and increasing the scour.

The sludge is further subject to disturbance by wave action when high winds prevail, a frequent occurrence in March. In such case the amount of suspended matter carrying over the weir from the filling basin shows a marked increase. Our basins have a working depth of about 14 feet. Similar effects of wave action have been noted in other reservoirs 18 feet deep.

The basin at the Chain of Rocks (52 acres) are all uncovered, all used in series, and therefore, subject to disturbance by each of the agencies affecting their successful working.

Character of Sludge.—Suspended matter with the coagulum produced by chemical treatment subsides rapidly, undergoing a change in volume during its accumulation in the bottom of basins. When freshly formed it is loose, disseminated through the full volume of water in which it forms; under average conditions after 1½ hours it occupies about 3 per cent. and after 24 hours about 2 per cent. of the original volume. After this lapse of time only the newly precipitated portions are disturbed by gentle currents.

Opening mud gates at 8-hour intervals seems to reduce the sludge only near the gates, since it follows in a general way the contour of the bottom of the basin and is of such consistency that it does not flow readily over the compact material of earlier subsidence. The tendency is for each new deposit to collect more thickly upon the highest points of previous deposits.

Bacterial Removals.—Bacterial purification, as shown in Table IV., is proportional to the degree of clarification, falling a little below the percentage removal of suspended solids for the reasons which are cited below.

Table IV.—Removal of Bacteria With Suspended Solids.

	Suspended solids. Parts per million.	Suspended solids. Per cent. removal.	Bacteria per cu. cm.	Per cent. removal.
River	1,444	.....	57,000	.....
Basin 1	14.0	99.01	933	96.1
Basin 2	12.1	99.16	.....	.....
Basin 3	8.4	99.4	500	99.1
Basin 4	7.1	99.5	.....	.....
Basin 5	5.8	99.6	100	99.8
Basin 6	5.6	99.6	.....	.....
Clear well	2.6	99.8	42	99.99

Bacteria entangled in the natural sediment of the water, and gathered into coherent masses with the coagulum, concentrate in the sludge to the extent of 1,000,000 or more per cu. cm.; they are subject to disturbance and dissemination through basin contents by varying currents, however produced, and are easily carried through latter basins to the clear well.

It has been observed that slight changes in temperature of the influent water, causing almost infinitesimal differences in the density from that of water at different levels in the basins, give rise to turbid, polluted effluents from each basin in series, as the less compact layers of sludge are moved; that overturning, which in large bodies of deeper water occurs but twice a year, may occur several times a week when warm and cold days alternate in spring and fall; and that with a slight rise in suspended matter carried from the older sludge in the filling basin may come an altogether disproportionate increase in bacteria, by reason of alterations in the rate of pumping, or the currents produced by high winds sweeping along the surface of a half mile of water. When it is considered that the combined surface of water exposed to winds and temperature changes is more than 52 acres it will not seem idle to refer to what might at first appear entirely negligible factors. See Table V.

An abrupt change in the rate of flow through basins may cause the sludge to carry its burden of bacteria through successive basins, e.g., on August 17, 1912, such a change occurred, followed on the 19th by the appearance in the clear well samples of contamination with organisms of the B. coli group.

Change in the direction of flow incident to cleaning and restoring a basin to service affects both suspended solids and bacteria per cubic centimeter in the finished water. Basin 1 was thus put in service June 6, 1912. The rise of bacteria in clear well samples was from 150 per cubic centimeter on the 6th, to 3,300 in the following week. In this case irregular pumping (at rates ranging from 70 to 120 million gallons per day) was a factor in producing bad results.

Table V.—Effect of High Winds on Bacterial Counts.

	February 17. Bacteria per c.cm.	February 17. Per cent. removal.	February 24, 1909. Bacteria per c.cm	February 24, 1909. Per cent. removal.
River	24,500*	.....	33,700*	.....
Basin 1	1,550*	93.67	2,470*	92.68
Basin 3	1,000	95.92	890*	97.36
Basin 5	338	97.80	820	97.57
Drawing gate	720	97.06	2,960	91.22
Terminal chamber	1,325	94.59	3,475	89.70
Tap	6,563	73.21	13,750	56.26

It is apparent that bacterial reductions are subject to disturbance from too many factors to give constant results. We have no safeguard against turbid, contaminated water under these conditions. Table VI. shows the disproportionate increase of bacteria released by stirring previously deposited sludge.

River samples usually give evidence of the presence of bacteria of the B. coli group in 1,100 cu. cm. The finished water has given counts of more than 30,000 bacteria per cu. cm. on gelatine at 20 per cent. C., and members of the B. coli group have been found in 6 per cent. of tests on 1 cu. cm. samples in a single month.

Table VI.—Bacterial Increase in Clear Well After Basin Cleaning.

1912.	Suspended solids.	Bacteria per c.cm.	Per cent. removal.
June 6*	15	150	99.6
" 7	12	250	99.6
" 8	14	300	99.4
" 9	..	....	....
" 10	11	775	98.2
" 11	12	1,100	97.2
" 12	10	475	98.6
" 13	11	2,075	93.0
" 14	9	1,500	94.8
" 15	10	3,300	92.9

In reviewing bacteriological results for past years there is noticed a very wide divergence at any one sampling point, and extremely irregular counts for a given period at various points in the clarification system. The utmost we can hope for is a large percentage reduction of bacteria. We can have

*Note—Bacteria of the B. coli group present.

no assurance that the water which enters the distribution system will be free from pathogenic organisms regularly. While the improvement in the character of the effluent since the introduction of the clarification scheme seems to have reduced the typhoid death rate, the quality is still far from that of a good filter plant.

Residual Solids in Distribution System.—Water leaving the clear well contains small quantities of suspended and dissolved iron compounds, small particles of calcium and magnesium compounds, and larger quantities of silt and silicious matter too fine to be deposited during rapid flow through the sedimentation system. The amount of this material daily introduced into the distribution lines during the first year of operation, calculated from suspended matter and daily consumption, was as high as 27.5 tons, averaging 8.7 tons per day for the ten analyses referred to above. See Table VII.

This material is intermittently discharged from taps over the city in a very irregular way. At the laboratory of the city chemist samples are collected daily for analysis. Comparison of suspended solids in the clear well and at this tap illustrates the extent of this irregular deposition and displacement, as shown in Table VIII.

It is a matter of common observation that after unusual draught upon the mains in a portion of the system, very high turbidity appears, local, or affecting large sections of the city, according to the degree of the disturbance. Following a large fire complaints of turbid water are very numerous. So long as our practice continues sedimentation in the mains, the department cannot resent protests of consumers at turbid water when the accumulated solids are intermittently flushed out.

Table VII.—Average Weight of Suspended Matter in Daily Supply.

	Solids in tons.	Consumption in million gals.
1904-1905	8.7	79.0
1905-1906	2.35	69.0
1906-1907	1.05	70.1
1907-1908	0.31	68.9
1908-1909	0.5	70.7
1909-1910	0.34	75.4
1910-1911	0.92	76.1
1911-1912	1.74	83.5

Incrustation in Distribution System.—Because ours is a partially softened water there is always a certain variable amount of calcium carbonate present in the finished product. The softening process is completed slowly at summer temperatures and in winter is incomplete even when the water passes to the distribution system. There is, therefore, more or less deposit of calcium carbonate in mains and service pipes. Even with high bicarbonate alkalinity in the filling basin the water leaving the sixth or ninth basin is still supersaturated with calcium carbonate.

Connection with a 7-foot steel flow line was made in January, 1908, and the city supply drawn through it for 74 days. Examination at the end of the period disclosed a deposit, principally of calcium carbonate, 1/16 inch thick when moist, which shrank to 1/32 inch in drying. The water had an average total alkalinity of 59 p.pm., of which 25 were due to neutral carbonates and 34 to bicarbonates. Temperatures ranged from 32 degrees to 47 degrees Fahrenheit.

During the earlier years of operation there were notable deposits in meter gears, fish-traps and the like.

While the deposit in the distribution sys[illegible] n[illegible]t now seem to be increasing rapidly, there is [illegible] crustation in progress, due to the blending of unequ[illegible] ened waters. Trouble from this source can be lessened [illegible] longer storage, which will equalize the quality of the wat[illegible] before passing the high service pumps—a very costly expedient; or by so regulating the degree of softening that the finished water shall show a high degree of uniformity—a difficult matter when the raw water is changing quickly. Lower regular velocity through the settling basins would allow longer time for softening reactions; this entails the use of several filling basins, instead of but one with the rest in series. Finally, further reduction of this trouble could be effected by changing the order of chemical treatment, adding lime first and agitating the treated water before the charge of iron sulphate is applied.

Fig. 1.—Diagram Showing Relation of Consumption to Classification, St. Louis Waterworks.

There are several methods of arriving at a standard of judgment for considering the efficiency of coagulating basins as full and final preparation of water for distribution to consumers; comparison of the quality of the effluent with respect to clarity and bacterial content (a) with that of the previous supply, (b) with untreated water from day to day, or (c) with the effluent of a well operated filter plant.

Table VIII.—Intermittent Sedimentation in Mains. Suspended Solids in Parts per Million.

	Clear well.		Tap—city chemist's laboratory.	
1905-1906.	Max.	Average.	Max.	Average.
April	..	..	8	6
May	40	13	22	21
June	6	3	25	15
July	21	7	162	81
August	34	12	20	16
September	26	10	20	17
October	19	6	12	8
November	7	6	13	11
December	30	9	12	12
January	15	9	4	2
February	14	7	0	0
March	12	8	12	6

During the first year of operation at Saint Louis the weight of solid matter carried into the distribution system averaged 25 p.pm.—ranging from none to 97 parts; the reduction was about 98 per cent. reckoned on the weight of solids in the raw water. While this was a decided improvement over conditions prior to treatment the introduction of an average of 8.7 tons of suspended matter per day into the mains left much to be desired if one compares this result with the standard set by a satisfactory filter plant, whose effluent contains no weighable quantity of solid matter in

suspension, and shows no visible turbidity or opalescence in bright sunlight.

The local standard of purity has advanced from year to year since the clarification system has been in operation. Prior to 1904 sedimented water containing 60 to 450 p.p.m of solids in suspension was accepted, if not approved. Compared with that standard, the quality of water furnished in 1904-1905 was excellent. The next year showed a marked improvement, and established in turn a standard for comparison of the succeeding year's supply. With each subsequent year the quality of water furnished has been progressively better, until 1910-1911, when consumption so far exceeded the plant's capacity that there was a falling off in the quality of the effluent, although it was still superior to that supplied before 1907-1908. The capacity of the present plant must be increased. The extensions and changes made must provide a better effluent than the present public has been educated to demand.

It is apparent that the addition of a filter plant to the coagulating basins is essential if the residual sediment is to be finally removed, and the high color which sometimes characterizes the raw water is to be reduced to an acceptable degree. Operations under prevailing conditions in a plant of this size and character do not admit of the close control possible in a filter plant, where the units (filters) are small, subject to immediate supervision and washing, and their output regulated by rate controllers. Furthermore, with filters the solid matter collected with entangled bacteria is quickly and permanently removed from water passing through them; whereas coagulating basins give too frequently only a temporary separation. It is manifestly impossible to interrupt the flow through any one basin at will, should the water in it prove unfit for use, without seriously affecting the contents of other adjacent units by altering the course of currents through them. Nor is it possible to wholly eliminate the previously accumulated sludge in filling and sedimentation basins, so that after cleaning the first water passing through them shall be faultless.

With seven filling basins and six additional new reservoirs for sedimentation, as considered in a report made by the writer, there would be effected at best only a percentage reduction of suspended solids and bacteria, with no assurance of a safe, clear, sparkling effluent. Irregularities incident to a plant of this character, where pumping and drawing and the consequent period of sedimentation are subject to wide variations directly affecting the finished water, can be avoided only by filtration.

The abridged form of treatment adopted prior to the World's Fair has beyond question served a very useful purpose. The question has arisen whether the present system of partial softening, coagulation and sedimentation shall be extended by adding further sedimentation basins to the already existing plant, or supplemented by a filter plant which shall afford a perfectly clear water at all times, with fairly constant bacterial removals and the possibility of immediate control of operating conditions. The cost of constructing two basins of 40,000,000 gals. capacity each was about $7,500 per 1,000,000 gals. capacity.

It is hardly possible to make the necessary changes in present basins and add the required reservoir capacity to provide for clarification of the volume of water which will certainly be consumed within the next ten years at a cost of less than $1,500,000. Whereas a filter plant added to the present basins with certain changes outlined comprising 40 filters of a normal rating of 44,000,000 gals. in 24 hours, can be constructed at a cost of about $1,250,000.

There are locations where basin construction is cheaper, where prolonged sedimentation in very large reservoirs may be advantageously used in producing an acceptable effluent for a time—until the public forgets its earlier satisfaction with an improved water supply, and clamors for further betterment. Before such installations are begun there is need of very careful study of the quality of the untreated water, to show its adaptation to coagulation methods and good judgment as to arrangement of the plant with a view to the ultimate addition of filters.

CONCRETE SWIMMING BATH AT SOUTHAMPTON.

By J. A. Crowther, A.M. Inst. C.E.*
(Borough Engineer and Surveyor, Southampton.)

The original bath, which was constructed some years before the writer of this paper came to the town, was presented to the Southampton Corporation by Mr. Tankerville Chamberlayne, Member of Parliament for the Borough.

The bath was originally 156 feet long by 30 feet wide, having a depth of 6 feet. The ground proved to be very treacherous, being on the bank of the River Itchen at Northam, and the bath was, and is, filled by the rising tide. Therefore, it will be seen that two forces must be provided for: (1) When the tide is out and the bath full of water; and (2) when the tide is high and the bath empty.

To meet the requirements of condition (2) it is evident that the bath must be securely anchored to the bed of the river to make sure that it shall remain in position when empty, and a high tide prevails, otherwise the bath might go sailing gaily down the river, possibly to the detriment of shipping.

Soon after the old bath was brought into use cracks in the walls and floor developed, and to such an extent that it was found to be impossible to keep the water in the bath when the tide was out.

Tests were made by closing the inlet valve, and allowing the tide to rise outside. The result was that as the tide rose a distinct tremor could be felt by any person standing on the edge of the bath. Further it was found that wooden wedges loosely inserted at low water and with the inlet valve closed, could not be withdrawn by hand when the tide had risen.

Under the above circumstances the author could not advise the Borough Council that it would be safe to use the bath, even when it contained a sufficient quantity of water.

In February, 1903, the author submitted two schemes to the Baths Committee for reconstructing the bath, and making adequate provision for withstanding the forces arising under the two conditions to which reference has been made.

Scheme 1 was for ordinary elm piles with a concrete superstructure.

Scheme 2 was for ferro-concrete on the Mouchel-Hennebique system throughout.

The estimate for Scheme 1 was $5,106.03, and that for Scheme 2, $4,623.90, and, being distinctly of opinion that ferro-concrete work will last as long or longer than ordinary timber piling, the author advised the Council to accept Scheme 2.

On account of expense, and in order to obtain better foundations, it was decided to construct the new bath of

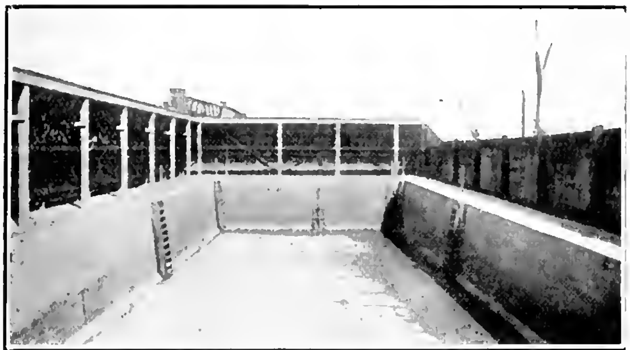
* From a paper read before the Institution of Municipal and County Engineers, England.

smaller dimensions than the first one, this being done by curtailing the projection of the bath into the river.

The dimensions of the new bath are 75 feet by 30 feet, by 7 feet deep at one end and 4 feet 6 inches deep at the other, having also a filter or straining chamber 30 feet long by 10 feet wide.

The greater part of the old bath was removed, but the side walls of the remainder were left so as to provide a promenade for the new part, care being taken to ensure the proper bonding of the old and new work.

Method of Construction of the New Bath.—The whole bath and filter are carried on twenty-two ferro-concrete piles, 14 inches square by 32 feet long, longitudinal ferro-concrete beams, 5 inches wide by 10 inches deep, spaced 4 feet 10 inches apart, centre to centre, and ferro-concrete cross-beams, 7 inches wide by 10 inches deep, laid 9 feet 4 inches apart, centre to centre. The specification provides that in the driving of the piles the set should not exceed half an inch for the last ten blows of a 30-cwt. monkey falling 30 inches.



Open Air Swimming Tank.

The formula used for calculating the resistance of the piles was the usual one of L = WH/8D.

Where L = Safe load on pile in tons, W = Weight of monkey in hundreweights, H = Fall of monkey in inches. D = Set of pile in inches.

The set of every pile was carefully observed, and hereunder will be found a few examples:—

Pile No.	Length of pile. ft. in.	Length driven, ft. in.	Set, in.
11	32 0	28 9	⅛
12	32 0	28 0	½
13	32 0	27 6	½
14	32 0	26 9	½

It will be noted from the above table that, although the piles were made 32 feet long, the distance driven was from 26 feet 9 inches to 38 feet 9 inches, at which depth the required resistance was obtained.

The concrete was then stripped off the projecting portion of the piles, and the steel bars bent over and thoroughly interlaced with those of the horizontal and cross-beams.

The floor and walls are 4½ inches thick. The concrete walls of the old bath (before referred to as being left as a promenade), are carried on the cross-beams, which were continued through the pile heads, and about 15 inches under the old walls. A chase was then cut vertically in the old concrete wall and the cross-beam continued upward on this chase as a counterfort. The steel work of the whole structure, including the piles, beams, floor and sides, was all tied together and interlaced by means of straps and the main bars, so that the whole was securely bound together.

The piles were made in wooden moulds laid horizontally, and the reinforcement of each pile was made up of four 1¼ inches diameter bars running the entire length of the pile, these bars being braced together with links or stirrups of 3-16-inch diameter. The steel work was first placed in position so as to leave a space of about 1½ inches (not less than 1 inch) between the steel and the wood framing, in order that the concrete might entirely surround the metal and preserve it from the action of sea water. The mould was then filled up and carefully punned so as to make a solid mass.

The piles were turned in about fourteen days, and then left for further seasoning. When considered to be sufficiently hardened, the piles were placed in an upright position for driving, and in this position the atmosphere could play on all four sides of the pile, and so quicken the process of seasoning. While in the vertical position each pile was watered every day before being driven.

As it was necessary to complete the work as soon as possible, some piles were made up with concrete in the proportions of 1 part of Portland cement to 3 parts of sand and aggregate, and driven three weeks after having been made.

The specification provided that the concrete for the piles should be in the proportion of 1:5, and that for the sides, floor and beams in the proportion of 1:4. The specification for the concrete was very stringent. All the cement was carefully examined and tested for specific gravity, fineness of grinding, tensible strength and soundness. Care was also taken to secure clean aggregate.

Well knowing the difficulty of securing good concrete work in tidal waters, and especially in Southampton, where we have four tides to be contended with each day, the author attached much importance to securing a good contractor, and to a stringent specification governing both workmanship and materials.

The first condition was secured by adopting the Mouchel-Hennebique system of construction, as this firm insist upon their work being carried out by licensed contractors, which, of course, means that none but good and experienced men are employed.

The specification provided that upon the completion of the work the bath was to be charged with water to high water of the highest spring tide, and to remain so for at least forty-eight consecutive hours; then to be left completely empty for the same period, and to remain perfectly watertight and sound in every detail under these conditions before the engineer would give his certificate as to final completion, and that the contractor should maintain the bath in such watertight condition for a period of twelve calendar months. Although the contractor experienced great difficulty in doing this, he succeeded and left the bath as specified.

The view reproduced in the accompanying illustration shows the new bath when empty.

REINFORCED CONCRETE COALING STATION.

A locomotive coaling station of reinforced concrete of 2,000 tons capacity, has recently been built for the Philadelphia and Reading Railway at Philadelphia. The building, which spans seven railway tracks, is supported on seven rows of five columns each, and one end row transversely, the rows of columns being parallel to outer lines of tracks. The floor of the bunkers is of sufficient height above rail level to permit the largest engines to take on coal and discharge ashes.

GAS DISTRIBUTION IN TORONTO.*

By D. L. Hill.

[NOTE.—Municipal engineers are frequently confronted with real problems caused by gas mains crossing the underground work of other corporations, such as telephone, conduits, water mains, etc., and it is felt that the paper printed herewith will prove of considerable interest to many of our readers who are coming in contact more or less frequently with this difficulty.—Ed.]

In taking up the subject of gas distribution, the question is so broad and the time at my disposal so brief, that nothing more than a mere synopsis can be given of the various operations connected with this branch of the industry. For this reason I have divided the subject into sections, so as to be more easily understood and followed.

The view of the lantern slide shows the trunk main system of Toronto, and is confined to cast iron pipe only.

Street Mains; Their Functions.—Street mains bear the same relationship to the gas company as the delivery wagon bears to the merchant; they both deliver to the point of consumption the commodity sold. It is a noticeable fact that a mercantile house doing a large volume of business covering a wide area, has delivery wagons made of various sizes. For local delivery, small one-horse wagons are used, but for suburban and interurban delivery, large trucks and vans are employed with a capacity several times greater than for local duty.

The analogy is apparent when applied to gas mains, hence the diversity of sizes. The large, or trunk mains, as they are usually called, carry the gas away from the holder to the distant points of consumption, the intervening territory being interlaced with what might be termed intermediate trunk mains, which are fed by the larger ones. These intermediate trunk mains divide the city into sections, comprising many streets and blocks, and it is from these intermediate mains that the service mains derive their supply.

Sizes of Mains.—The sizes of the various feeder mains are determined by Pole's formula for the flow of gas in pipes when the quantity, or volume, of gas to be delivered is known, but, unfortunately for the gas engineer, this is not always obtainable, for oftentimes large building operations are launched in isolated sections of the city which develop quickly into an area of large consumption, a condition which in no way could be pre-determined. Therefore, unless the feeder mains have been laid of ample capacity, the company would be put to considerable trouble and expense to meet the increased demand, so that the decision as to size of these mains rests largely upon a question of judgment born of experience and knowledge of local conditions.

The size of service mains is determined more from the standpoint of durability and economy than of capacity, for in the majority of cases where 4-inch mains are laid a 2-inch or 3-inch would amply supply the maximum demand, but owing to the structural weakness of the smaller sizes, causing the supply to be frequently interrupted by breaks, stoppages by "trapping," etc., attended by the necessity of immediate and expensive repairs, it is more economical to adopt a liberal policy regarding the sizes of service mains; the company's rule being to lay nothing smaller than 4-inch.

Peak Load, or Maximum Demand.—The question of maximum demand might be of sufficient interest to mention in passing. If it were possible for the daily consumption to be uniform for each hour of the twenty-four, it would mean a great economy to the company in street mains, but the mains must be of sufficient capacity to meet the demand at "peak load." By referring to a Bristol recording gauge chart it will be noticed that the time of this increased demand is variable, but in general it occurs between the hours of 5 and 7 p.m. daily, during the fall and winter months, due to the overlapping of lighting, industrial, and domestic loads. The extreme "peak load" will cover a period of perhaps 15 minutes, in which time the consumption is increased many times over any other similar period out of the 24 hours, necessitating a severe tax on the main system, while some other periods of the day have practically no consumption. To increase the consumption of gas during these "off periods" is a desideratum which is vigorously encouraged by the company through the sale of industrial appliances, thus bringing a return from a heavy investment in a main system at a time when it would otherwise be earning little or nothing.

Main Laying.—Mains should be laid in a straight line and of sufficient depth so that it will preclude any possibility of disturbance, either from street traffic or climatic changes. The first consideration can be omitted, for if a main is laid below the normal frost line in this climate the possibility of disturbance from street traffic is very remote, besides, our mains are laid chiefly between the curb and the street line, so that heavy traffic could only affect the mains at street crossings. The custom is to lay mains four feet below the surface and of the same grade as the street, but in many cases the mains are laid in advance of street grading, in which event the main is laid to a grade of 2 inches, approximately, for every 100 feet. When the grade reaches a level of one foot, more or less, below the normal depth, a "drip pot" is set, from this point the grade of the main is upward until the summit is reached at normal depth, when the grade again is turned downward. The necessity of this gradient is due to the fact that the aqueous vapors held in suspension in the gas while in the holder are thrown down, or condensed, when subjected to the varying temperatures of the street main. This condensation then flows to the "drip pot" by gravity, to be pumped out at intervals.

The trench should be no wider than is necessary to lay the main, which should rest on good firm earth, for if it sags or settles, the condensation finds lodgment there, thus restricting the flow of gas, or completely obstructing it if the sag is deep enough. After the trench is ready to receive the pipe, the spigot end is brought home into the bell of the preceding length, care being taken to see that the bell and spigot end are perfectly clean before entering. This jointing space is then filled to within 1½ inches to 2½ inches of the face of the bell (the depth varying with the size of the pipe) with jute yarn twisted into a rope of sufficient size to completely fill the joint space, after which it is driven up hard with hammer and yarning iron so that it is gas tight. The remaining space is now filled with molten lead. This operation is performed by placing a lead rummer, or dam, made of asbestos rope, around the pipe immediately in front of the bell, the ends being turned out and held by a clamp, leaving a triangular space for the "gate" through which the lead is poured When cool, the lead runner is removed, the lead forming a fillet, outside the bell, which is then upset with a hammer and cold chisel, followed with caulking tools of varying thickness until the last or finishing tool completely fills the jointing space. When the joint is finished the lead is flush with the face of the bell.

In general, mains should be laid with as few bends as possible. In turning sharp curves the pipes should not be "broken" or swung over at each joint until the desired curve is reached, but circle bends should be used, for it is

* Paper read before the Consumers' Gas Company Educational Association meeting, April 8, 1913.

impossible to make a good joint when the pipe is not in line. At the junction of intersecting streets special pipe castings are placed so that at any future time it might be necessary to make a connection with this main, an outlet is ready, thus obviating the necessity of cutting out and inserting a branch.

Leak Work.—No matter how carefully the main laying is done, leaks are sure to develop, for it must be borne in mind that the gas company has only the same rights as any other corporation enjoying the privilege of using the streets for their underground operations. In a densely populated city, like Toronto, the underground work of other corporations frequently comes in contact with our mains, thereby disturbing the earth surrounding them. In the course of time through the settlement of the newly filled trench, our main is carried down with it, attended by leaky joints and frequently causing a break.

As soon as the report of a leak in the street is received, a survey of the surrounding territory is made immediately to locate its source. It might come from a dozen causes, such as broken stand-pipes, defective house piping or fittings, leaking meter, etc., any of which is comparatively easy to find and repair, but a leaking main or service requires different treatment, and is frequently attended with no small amount of danger, particularly if the main is in close proximity to some other foreign structure such as an electric conduit, or telephone duct. As these structures are not tight enough to prevent the gas from entering, it is liable to be carried long distances from the source of the leakage and its presence is manifested at the nearest manhole. The accumulation of gas in this confined space only requires a spark to create an explosion, at times resulting in serious injury to life and property. When the leak is in a street where no such foreign structures exist, it is usually found by "barring" over the main. This operation consists in driving a steel shod bar through the earth over the main, the leak being detected by the odor coming from the opening after the bar is withdrawn. If the leak is found to be at a joint, the lead is merely recaulked, but if the main is broken a temporary repair is made by wrapping the fracture with a bandage of soaped muslin until a split sleeve can be procured and put into place, i.e., if the break is of such a nature that it can be repaired in this way. A "split sleeve" is what its name implies—a sleeve, split or divided through the centre, and held together by bolts through flanges cast on either side.

To place a split sleeve in position, the main is scraped thoroughly clean, and millboard, after being softened in warm water, is placed between the flanges, the bolts are inserted and the nuts brought up tight, so that the millboard is compressed into any unevenness in the iron, which, when dry, gives a permanently tight joint. The jointing space between the sleeve and main is made up by first driving in jute yarn, which is then followed by molten lead, similar to an ordinary bell and spigot joint. If the break is longitudinal, the affected section of pipe must be removed and a new piece inserted. This operation necessitates the interruption of the gas supply, if the main is fed from one way only, in which event the consumers affected must be notified that the gas will be shut off while repairs are being made.

The gas is shut off when repairs or the connection of two mains are being made, by drilling a hole in the main of sufficient size as will admit a rubber bag. This bag is made of thin sheet rubber, from one to two inches larger than the diameter of the main, to which a hose is attached for inflating. For the smaller mains the bag can be easily inflated by placing the end of the hose to the mouth and blowing, but for larger mains a "stopper" is usually employed in conjunction with the bag, the bag being inflated with [illegible] air pump.

The "stopper" consists of two flexible strips of whalebone to which is fastened oiled canvas of the diameter of the pipe. When pressure is exerted on the ends the centre portions spring outward in the form of a hoop, bringing the oiled canvas taut, thus relieving the gas pressure from the rubber bag.

Services.—It is through the service that the consumer receives his supply from the street mains. The company install all services gratis when the building is on the street line, but if the building sets back from the street line a small charge is made to run the service from street line to building, being merely sufficient to cover the cost. It is the policy of the company to maintain these services and ensure the consumer an adequate supply permanently, even if subsequent appliance installations would render it necessary to lay an entirely new service in addition to the one already in place.

The considerations affecting the size of pipe to be used for services are, generally speaking, maximum demand, distance from main, and economy of maintenance. By taking into account the number of outlets or gas-consuming appliances, and assuming them to be all in use, the maximum demand is easily computed. The length of service to be run is known, and its size is readily determined by the use of Cox's gas flow computer, which is a circular slide rule, as it were, which graphically solves Pole's formula for the flow of gas in pipes. But in this relation it will be found in the great majority of cases a one-inch or even a three-quarter pipe would meet all requirements regarding size for ordinary dwellings, while the question of economy would dictate a larger size. The prevailing practice is to lay no services smaller than inch and a quarter. The small extra cost of this size pipe over the smaller sizes is not a very large percentage of the total cost of the service, while it will provide for a possible increase in the amount of gas required. Its greater weight also adds considerably to the life of the service and is not so susceptable to become "trapped" by condensation due to settlement. The pipe is coated with a coal tar preparation before being laid.

The service is connected to the main by means of what is termed a "street tee" and "ell," which, when connected, forms a swing joint, thereby relieving the strain on the street main in case of any movement. The service is connected by drilling and tapping a hole in the upper side of the main in which is inserted the street tee. A wood or rubber plug is placed in the open end of the tee, thus shutting off the gas from the service until the work is completed, when it is removed and replaced with a screw plug. In making the hole in the main the old method was to chip a hole in the pipe with a cape or diamond pointed chisel, as close as the eye could judge for size, after which it was reamed and tapped. This method is not unknown to-day, but the practice must be discouraged, for in case the hole is chipped too large, it will not permit a full thread to be made when tapped, in which event the hole is made a size larger, subjecting the workman to the danger of being overcome by escaping gas, not to mention the weakening of the main thereby. A very ingenuous device which is in general use to-day drills and taps the hole in one operation with little or no escape of gas.

The service is laid on solid earth with an incline towards the main so that any condensation from the gas will not be carried into the building. Anyone who has ever encountered the odor of this condensation in the house will appreciate this precaution.

House Piping.—This is a branch of the business over which the company has little or no control, except in an advisory capacity. The house piping is usually installed by a steam-fitter or plumber while the building is in course of erection, and is too often left to his discretion as to size, etc. In the interests of economy, without regard for the duty they are to perform, the pipes installed are usually too small, in which event the gas company is condemned for not furnishing an adequate supply when the whole trouble rests with the house piping.

Various tables or rules are in use setting forth the minimum sizes of house piping which should be used, based upon the knowledge of the quantity of gas to be supplied, through a given length of pipe, with an allowable drop in pressure of 1/10 inch for every 50 feet. The necessity of some regulations relative to the size of house piping has been brought home very forcibly through complaints of insufficient supply that the company is now co-operating with architects and builders in this respect, in order that the consumer shall have an ample supply for any additional requirements.

As the question of meters was discussed at a previous meeting, I will not touch upon that branch of the business here.

AN INTERESTING EXCAVATOR.

We present herewith two illustrations of a rather interesting machine which is now engaged at the works of the Tofield Coal Company, at Tofield, Alta. This machine is capable of excavating at a high or low depth from six to nine meters, and giving an output of 1,100 cubic yards in light dry soil.

It is worked on the continuous bucket system, and has a bucket at every sixth link. These buckets work in a guided ladder which is pivoted at the inner end to the body of the machine, and suspended by wire ropes from steel jibs, and can be raised or lowered as required.

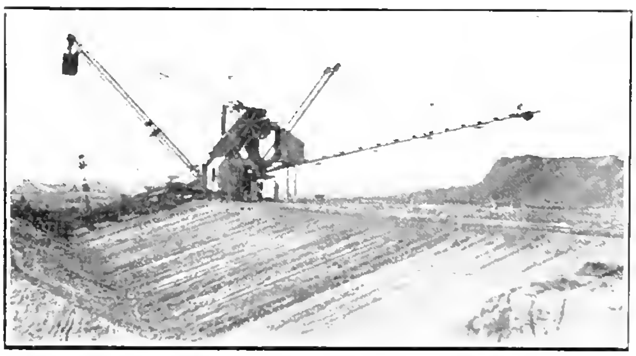


Fig. 1.

The chain of buckets is worked by a hexagon tumbler at the top of the machine, and the buckets empty into a hopper as they pass over the tumbler on which is fitted a cleaning knife to ensure the emptying of the buckets.

The hopper guides the excavated material on to a belt conveyer 26 meters long, which works at an inclination of 15 degrees.

The whole excavator is supported by springs on twelve wheels running on a track consisting of three 90-lb. rails.

The power is derived from a horizontal tubular boiler and twin cylinder engine, and all the motions of the machine are derived from this engine, and they consist of the following movements: Travelling of the machine backwards or forwards; lifting or lowering the bucket ladder; stopping or starting of the buckets (all controlled by three levers worked by one man).

All these movements are got by an arrangement of toothed wheels and pinions, and fitted with friction clutches to ensure no breaking of the teeth should the machine be overloaded or the buckets meet any obstruction.

Fig. 2.

The method of working the machine is to level the earth in front by the machine travelling backwards and forwards over the higher parts until these are level with the lower, then to set a cut by the machine of from five to six inches depth, and travel the machine along the full length of rail and on completion of each cut to lower the bucket ladder another five or six inches for the return cut, keeping the buckets working continuously.

The machine is at present excavating below its base. On a sufficient opening being made to allow the machine to work in the excavation, the machine will be moved on top of the coal. A strip of coal will be removed parallel to the cutting, broad enough to allow the railroad to be laid alongside the cutting, and also sufficient space to deposit the excavated material from the end of the conveyer beyond the railroad. The machine will then excavate the earth above the coal, and deposit beyond the railroad in the space the coal has been cleared from.

As the track of the machine is moved in closer to the bank (which will be about 12 feet at each move, this being the length of the horizontal piece at the bottom of the ladder) it will leave a strip of coal 12 feet broad to be taken away at the back of the machine, with a railroad alongside the coal, and as this strip of coal is removed, the rail-track will be moved up to the coal face again, and by this method the coal can be loaded direct into the cars.

This machine is manufactured by the Lubecker Machine and Manufacturing Company, and was supplied by F. S. Dudgeon, Limited, of London, England, and is the usual A. type machine supplied with the conveyer.

COST COMPARISONS OF ELECTRIC AND HORSE-DRAWN TRUCKS.

Interesting figures are published in the April issue of the Journal of the American Society of Mechanical Engineers with regard to the findings of an investigation into the comparative cost data of electrically equipped trucks and horse drawn vehicles made by W. R. Metz, superintendent of the government office, Washington, D.C., for purposes of ascertaining the desirability of replacing the horse-drawn wagons with electric motor trucks. An abstract of the report is published below:—

In the preliminary investigation figures were obtained on a 2,500-lb. electric truck that had been in service at the Washington naval gun factory for four years. The cost of operation and the saving accomplished were as given in Table 1. A 5-ton electric truck was in use there during the same period. Its cost of operation was about the same as for the 2,500-lb. truck, except that it cost $1.10 for charging per 40-mile radius as compared with 75 cents for the smaller truck. Its total cost of operation, including depreciation and interest, was figured at $2,843.84. It displaced two two-horse wagons, affecting a net saving annually of $2,460.92.

Table 2 gives cost figures for the single-horse vehicles of a large company using horse-drawn wagons and electric and gasoline machines. By adding the items for extra horser and harness, similar totals for two, three and four-horse wagons are found to be $740.52, $1,016.23 and $1,291.94.

In Table 3 are given the operating costs for the same company's electric trucks.

During the fiscal year 1910 the expenses of the stable section of the government printing office were $31,113.58, and those for the delivery section were $17,093.93, making a total of $48,207.51. The figures were slightly higher in 1911. Table 4 itemizes these 1910 costs, and from this table Table 5 is derived, showing the operating cost of one two-horse wagon of 5,000-lb. capacity.

Beginning in November, 1911, electric trucks and carriages of various capacities have been installed, and most of the horses and their equipment have been sold. Table 6 gives costs with the present equipment. The remaining horses are to be replaced, after which the four remaining stablemen will probably be supplanted by two helpers and a laborer, effecting a further reduction of $1,377.20 annually.

From the monthly cost records the operating cost of one 5,000-lb. electric truck is derived and shown in Table 7. One such truck replaces two two-horse wagons, the cost of which, as shown in Table 5, was $6,737.72. The annual saving due to the electric truck is therefore $4,204.39.

Based upon the assumption, in the absence of mileage figures for the horse-drawn wagons, that they averaged 12 miles per day—it being known that the electric trucks average 24 and make twice as many trips as the teams did—Table 8 is derived to show the comparative costs per month and per mile for operating the horse-drawn vehicles and the three sizes of electric trucks.

Table 1.—2,500-Pound Electric Truck.

Cost of truck	$2,230.00		
Labor for charging batteries		$ 46.44	
Charging		16.50	
Acid		18.00	
Rubber jars		15.00	
Batteries (partly renewed)		64.98	
Carbon brushes		1.80	
Repairs		99.96	
1 operator at $2.48 per day		776.24	
2 laborers at $1.92 per day each		1,201.92	
Totals	$2,230.00	$2,240.84	
Depreciation 10 per cent.		223.00	
Interest on investment at 2 per cent.		44.60	
Total cost			$2,508.44

Total mileage per year....3,366
Cost per mile $0.745
This truck displaced 5 horses and carts costing as follows:

5 carts by contract at $1.92 per day	$3,004.80	
5 laborers at $1.92 per day each	$3,004.80	
Total		$6,009.60
Net saving of truck over horses per year		$3,501.16

Table 2.—Horse-Drawn Vehicles.

Investment—		
1 horse	$250.00	
1 vehicle	125.00	
Harness	30.00	
Total	$405.00	
Maintenance and upkeep—		
Depreciation—		
Horse at 20 per cent.	$ 50.00	
Vehicle at 15 per cent.	18.75	
Harness at 15 per cent	4.50	
Interest on $405 at 6 per cent.	24.30	
Total		$ 97.55
Horse upkeep—		
Feed at 47.4 cents × 365 days	$173.01	
Shoeing at 7.5 cents × 365 days	27.38	
Veterinary at 1.1 cents × 365 days	4.02	
Total		204.41
Vehicle expense at 43.4 cents per day	$158.35	
Harness expense	4.50	
Total		162.85
Total expense exclusive of labor and stable		$464.81

Table 3.—Expense of Operating Electric Commercial Vehicles.

Capacity, Lb.	850-1,000	1,500-2,000	2,500-3,000	4,000	7,000
Interest and depreciation (machine less batteries and tires)	$244.50	$306.30	$391.40	$422.94	$470.84
Mechanical and electrical upkeep	67.54	84.15	101.70	110.96	121.42
Tire repairs and renewals	79.28	97.30	155.05	267.60	535.25
Battery repairs, cleaning and renewals	130.50	175.36	219.34	271.54	312.84
Current at 1 cent per kw. hr.	20.00	30.20	40.00	60.00	51.50
Totals	$541.82	$693.31	$907.49	$1,133.04	$1,491.85

Table 4.—Cost Data for Horse-Drawn Vehicles for Year Ending June 30, 1910.

Equipment—	
23 Horses (average per year)	$ 6,900.00
Harness, blankets, etc.	1,350.00
1 Five-ton truck (2-horse)	425.00
7 Large delivery wagons (2-horse at $475 average)	3,325.00
6 Single delivery wagons (1-horse at $275 average)	1,650.00
3 Light mail wagons at $200	600.00
4 Depot wagons (carriages) at $300	1,200.00
2 Coupes, with pole and shafts, at $540	1,080.00
Total	$16,530.00
Cost of operation of stable section—	
Wages of foremen and stablemen	$10,113.59
Wages of drivers	12,666.21
Rent	2,400.00
Feed	3,172.20
Supplies	959.62
Repairs to harness, wagons, etc.	626.86
Shoeing	906.60
Gas and electricity	268.50
Total cost of operation, maintenance and repair	$31,113.58
Depreciation, horses 20 per cent., harness 15 per cent., wagons 10 per cent.	2,410.50
Interest on investment at 2 per cent.	330.60
Total cost, including depreciation and interest on investment	$33,854.68
Cost of operation of delivery section—	
Salaries and wages	$17,085.93
Material and supplies	8.00
Total cost	$17,093.93

Table 5.—Cost per Year of One 2-Horse 5,000-Lb. Wagon.

Wagon expense—			
Cost of truck	$ 425.00		
Cost of maintenance and repair		$ 31.75	
Cleaning and washing		66.76	
Lubricants		1.00	
Depreciation, estimated at 10 per cent.		42.50	
Total			$ 142.01
Horse expense—			
Cost of two horses	$ 615.00		
Cost of feed		$264.33	
Cost of care (hostler)		702.60	
Cost of veterinary and office labor		250.10	
Cost of medicine		2.17	
Cost of shoeing		78.84	
Cost of blankets, nets, etc.	12.22		
Rental value of space (2 horses) (based on $2,400 for 22 horses)		218.00	
Depreciation, estimated at 20 per cent.		125.44	
Total			$1,641.48
Harness expense—			
Cost of harness	$ 123.00		
Cost of maintenance		$ 7.68	
Depreciation, estimated at 15 per cent.		18.45	
Total			$ 26.13
Miscellaneous supplies		$ 10.00	
Drivers' wages		751.20	
Helpers' wages		751.20	
Gas and electricity		23.34	
Interest on investment at 2 per cent.		23.50	
Total			$1,559.24
Total original cost	$1,175.22		
Total expense for one year			$3,368.86

Table 6.—Equipment and Number and Class of Men Now Employed.

Equipment—		
Two 1,000-lb. trucks	$ 4,639.00	
Two 2,000-lb. trucks	5,498.78	
Three 5,000-lb. trucks (two in use during full year)	10,625.22	
One 8,000-lb. truck (installed in January, 1913)	5,509.00	
One electrically driven carriage (installed in November)	3,671.00	
Total cost		$29,943.00
Wages		$28,276.96

Table 7.—Cost of Operating One 5,000-Lb. Electric Truck.

Cost of truck and equipment (including spare battery and parts)	$3,745.00	
Maintenance and repair		$ 581.53
Depreciation at 10 per cent.		374.50
Interest on investment at 2 per cent.		74.90
Chauffeur's wages at $2.40 per day.		751.20
Messenger's wages at $2.40 per day		751.20
Total original cost	[illegible]	
Total expense for one year		[illegible]

Table 8.—Costs of Electric Trucks and Two-Horse Wagon.

	2-horse wagon 5,000-lb. capacity.	5,000-lb. electric truck.	2,000-lb. electric truck.	1,000-lb. electric truck.
Average trips per day.	4	8	8	9
Mileage per day, average	12	24	20	20
Mileage per month (loaded halfway).	312	624	520	520
Average load per trip, lb.	4,000	5,500	2,500	900
Total load per month, tons	16,000	44,000	20,000	8,100
Total cost per month.	$280.74	$211.11	$187.81	$180.98
Cost per mile	0.899	0.338	0.361	0.347
Cost per mile (omitting driver's and helper's wages)	0.499	0.138	0.121	0.107

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, MAY 8, 1913. No. 19

CONTENTS OF THIS ISSUE.

MONTREAL AND ITS LOST OPPORTUNITIES.

Those of our readers who are at all acquainted with Montreal will appreciate and realize how much to the point is a criticism that Mr. T. H. Mawson, of the University of Liverpool, and who is an acknowledged international authority on the subject of Town Planning, makes regarding the city's lack of appreciation and making the most of their opportunities for a beautiful city. In his recent lecture in Montreal before the Greater Montreal Planning and Housing Association, his remarks as regards any attempts that have been made to make the most of its natural advantages were not by any means very flattering. It is hardly to be expected, in fact, that an observing man could fail to criticize.

Montreal's streets for a city of its size are probably the worst on the continent. While severe winter weather no doubt makes it hard to maintain good roads, nevertheless neither the weather nor the engineers are to blame for their absence, but the Civic Administration itself. It has always seemed impossible to persuade the majority of the aldermen of Montreal to take any kind of a broad-minded view of affairs, or to have pride in the construction and building up of a clean, well-built, beautiful city. Instance of civic lack of appreciation of opportunities and future needs are numerous. One occurred a few years ago in connection with the sale of some property belonging to the Redpath estate. This estate occupied part of the southern flank of the Montreal Mountain and abutted on Mount Royal Park. The purchase of it would have given the city, in addition to acreage, a beautiful driveway and entrance to the park from Sherbrooke Street, which had been long needed and was considered extremely desirable. The land was offered to the city at what those qualified to judge considered a most reasonable figure, and had behind it, we believe, a public-spirited consideration of the city's good. After a great deal of unnecessary delay and hesitancy and opposition on the city's part, the owners became disgusted, withdrew their offer, and it was quickly sold at a higher figure to real estate people, who have since used it for building purposes. A more utter lack of appreciation for the city park system and future good of the absent than that exhibited in the above case could hardly be found.

In his criticism of Montreal, Mr. Mawson stated that he had been in the city many times, and had always been struck with the magnificent opportunities which have been lost. The city has been laid out on the most unimaginative lines, and no cognizance whatever has been taken of its natural contours. This great natural amphitheatre overlooking the river offered opportunities for one of the most magnificent cities in the world. There were few sites which could compare with it.

On the subject of the streets and the steep grades of same, a suggestion which Mr. Mawson made which will appeal to all acquainted with the city's layout was that for the construction of a new and direct highway between Victoria and Dominion Squares. Such a road would do away with the steep traffic conditions encountered on such streets as Windsor, Bleury and Beaver Hall Hill. It is a subject which, now that the Canadian Northern is busy on the planning and construction of terminals and stations across the immediate path of the proposed road, should have been considered and provided for in the general layout beforehand by the Civic Government.

It is sincerely to be hoped that Montreal will shake itself of the lethargy it has shown in the past as regards the beautification of one of our finest cities.

THE LIVINGSTONE CHANNEL.

The opening of navigation of the Great Lakes continues to bring into public prominence the Livingstone Channel in the Detroit River. In last week's issue we spoke of it in connection with the work of the International Joint Commission, and their decision, re a proposed new dyke for maintaining the depth of water upstream from it.

At the present time of writing word has just come to hand of the grounding of a steamer in the channel which seriously threatens any navigation through it. When we consider the enormous traffic through the Detroit River, any threatened interruption naturally affects shipping interests to a very marked extent and the business public as well.

The Livingstone Channel was only formally opened on October 19th of last fall, and apparently the conditions are not yet ideal for traffic through it. Its construction was authorized by the United States Congress in 1907, and four and a half years were occupied in its completion at a total cost of ten million dollars. The channel was cut through practically solid rock for more than six of its thirteen miles of length, and runs in a direct line from above the head of Bois Blanc Island to deep water in Lake Erie.

The preparatory work was begun in the spring of 1908, when the contractors began erecting the cofferdam, which enclosed what is known as the dry-work section, about a mile of the river bed near the upper end of the rock cut. Actual channel digging was begun in the fall of the same year.

Originally constructed with a width of 300 feet, the dry section was completed in November, 1910, but was later widened to 450 feet, and addition being completed in December last, before the river was permitted to fill the enclosed space. Below the dykes for about five miles the channel has a width of 300 feet, while below that point, where the material to be removed was earth, the width is 800 feet. In the dry section the channel has a depth of 23 feet. Throughout the remainder of its length the least depth is 22 feet.

PROPOSED FEDERAL LAW IN REGARD TO THE POLLUTION OF NAVIGABLE STREAMS.

There has recently been appointed at Ottawa a Commission comprised of eighteen members of Parliament for the purpose of enquiring into the pollution of Canadian sources of water supply. The appointments are the result of the introduction for a second reading of Mr. Bradbury's Bill to prevent pollution of streams as above.

That the Government should take means to be advised on the subject, and to frame legislation in connection with same, is admittedly a most desirable step. It has been brought out in the past on several occasions that even the water of our Great Lakes, which ordinarily one would not consider on account of their bulk to be in any probable danger of general pollution for years to come, contain considerable amounts of chlorine at far distant points from sources of contamination. Analyses show, for instance, that the amount of chlorine in the west end of Lake Ontario has increased two and a half times in thirty years, while in the easterly end the amount of chlorine has doubled in twenty years. This increase in chlorine indicates sewage pollution, which, if not stopped or minimized, will in time render even our Great Lakes unsafe for use as a public water supply.

Consider the official figures, which show that the toll of death from typhoid in Canada is 35.5 per 100,000 of the population. In Germany it is only 7.6 and in England 11.2. Ottawa and Winnipeg are cities whose populations have suffered severely from epidemics of typhoid, due to the pollution of the Ottawa and Red Rivers, respectively. What they have gone through, other towns will have to combat with, unless steps are taken immediately to fortify with federal aid the sometimes inadequate and careless attempts of local municipalities to protect their water supply from dangerous contamination.

The ultimate aim of the Government in appointing the Commission is most admirable, but we cannot see that there is anything to be commended in their way of going about the work before them. The work in connection with this Commission could have been much more efficiently and rapidly carried through by the appointment of a much smaller commission composed of competent engineers and medical health officers rather than by an unwieldy body of non-engineering parliamentarians, whose appointment leaves a very probable opening for misunderstandings and mis-translations of engineering opinions and data given them. We cannot see any possible excuse, if efficiency is desired for such appointments. While this parliamentarian committee may wade through investigation to some beneficial and corrective legislation, they are, nevertheless, both on account of bulk of numbers and lack of training on the subject, unwieldy, slow and unfitted for the work.

It is time the Government was made to wake up to the fact that when reports and investigations are wanted on subjects relating to science, any ignoring of the professions concerned is dangerous to them, politically. The public should be made to understand the foolishness and unbusiness-like method of eighteen unscientific and wholly unqualified Parliamentarians enquiring into a matter which could be much better done by those acquainted with the engineering and scientific sides of the problems involved.

MONTREAL TRANSPORTATION PROBLEM

It begins to look as though Montreal would shortly find an exit from the tramways problem which has been worrying it so long. Two announcements have recently been made, either of which contains the elements of relief.

Recently the president of the Tramways Company approached the city with a tentative proposal. Later a conference was held at which something in the nature of a definite plan was placed before the representatives of the city. In this was outlined a scheme for the relief of congestion both immediate and future. Certain streets were asked for, for the extension of the company's lines. The programme was not unlike that proposed by Mr. Duncan McDonald. The Tramways president does not appear to have asked anything unreasonable. His proposal called for practically only one new line of any considerable extent, which line ran through a section of the city not now adequately served and upon streets to which there could be no particular objection. Other proposals were such as have been approved by the city council, such as making the stops less frequent. In the down town section it was proposed to use Victoria Square as a stopping point for certain cars instead of continuing

these through the congested district. Altogether the proposals seemed of a reasonable nature, and unless there is more behind them which has not yet been made public, there would not seem to be any good reason why the city should not meet the company in the matter. President Robert promised to put on a very much larger number of cars and to construct a roadbed of a superior character. Up to the present the city authorities do not appear to have given any very definite indications of how they regard the proposals.

Shortly after President Robert made his proposals to the city, fuller details concerning the Canadian Auto Bus Company appeared. It may be recalled that this company was organized some time ago to carry on an auto bus service in the city of Montreal. The company made certain proposals to the city, in which the city was to be a holder of a very considerable number of the shares of the company, this being the company's reward to the city, so it was thought at the time, for granting an exclusive franchise for ten years on certain streets. Objection to the arrangement between the city and the company was offered by a number of citizens and it it quite likely that the question is still before the courts.

At first, the names connected with the company were not those of well-known financiers, and a certain amount of doubt concerning the seriousness of the project was entertained. Within the past week, however, an announcement has been made to the effect that Mr. H. S. Holt, president of the Montreal Light, Heat and Power Company; D. Lorne McGibbon, president of the Canadian Consolidated Rubber Company; F. L. Wanklyn, general executive assistant of the Canadian Pacific Railway; are all mentioned in connection with the concern.

The capital of the company is $10,000,000, and the Canadian group, together with the English group, which has become interested in the concern, have already subscribed $1,500,000. The concern has a Federal charter which permits it to operate in any city in Canada.

The interesting features in connection with the above directorate is the mention of a number of names which have been spoken of as greatly opposed to projects of the president of the Montreal Tramways Company. It is generally considered on the Street that the Auto Bus Company will be strongly opposed to the Tramways Company. The franchise from the city of Montreal dates from last August, and according to the terms the company is obliged to give a five-minute service. It has been stated, however, that instead of a five-minute service the concern will give one which will be twice as frequent. The cars will be of the single deck variety on all steep grades, but it is not impossible that the double-deck variety will be employed on the leveller grades. The capacity will be from 28 to 38 people and the franchise insists that there shall be no strap hangers but that all passengers shall be provided with seats. The fares will be five cents, straight, and transfers to all lines of the company.

The city of Montreal has now spread clean across the island and extends a long distance east and west so that the auto busses will not be confined to a limited territory because of lack of ability on the part of the city to extend permission. The franchise, of course, only covers certain streets. Altogether it is expected that fifty auto busses will be running here by mid-summer, or shortly thereafter. There seems to be some disposition on the part of the city officials to delay action in the matter of the Tramways Company until the effect of the establishment of the auto bus service is felt. In the winter time the heating of the cars will be sufficiently accomplished through the exhaust.

AN INTERESTING HYDRAULIC INVESTIGATION.

In the fall of 1912 an investigation of the power possibilities for the town of Picton, Ontario, was made on the Mountain Lake power site by Mr. H. G. Acres, hydraulic engineer to the Hydro Electric Power Commission of Ontario. The report of the investigation appears in the last report of the Commission and is given herewith:

The Mountain Lake power site is owned by F. S. Wilson, Esq., of the J. C. Wilson Co., of Glenora, and hydraulic power is produced for the purpose of operating a machine shop, foundry and grist mill. The machine shop runs practically continuously six days a week, eleven hours a day, and uses about 28 h.p., while the grist mill and a storehouse, which use the greater amount of power, operate intermittently, being frequently closed for a week or more at a time.

The gross operating head is between 165 and 170 feet, the mean effective head being probably not less than 160 feet.

Mountain Lake, Approach Channel to Weir.

Although there is sufficient turbine capacity installed to generate about 130 h.p. it is probable that 75 h.p. would amply cover the average annual demand. On a basis of 66 hours a week operation the annual expenditure of energy would therefore, be about 257,400 h.p. hours. If this amount of energy were expended uniformly and continuously over the whole year of 365 days, it would be equivalent to about 30 h.p. continuous 24 hour power. With the turbine installation at present existing, this amount of power would be produced by a continuous uniform outflow from the lake of about 3 cu. ft. per second. Allowing 2 cu. ft. per second for leakage, the total discharge required would, therefore, be 5 second feet.

Five second feet flowing for one year would deliver a total volume of 157,680,000 cu. ft. of water. The area of the lake with its tributary water-shed could be reasonably taken at 600 acres, and assuming 12 inches of precipitation available for power purposes, the total surface inflow into Mountain Lake would amount to 26,136,000 cu. ft. per annum. Subtracting this amount from the total quantity above specified as being delivered to the wheels, leaves a remainder of 131,544,000 cu. ft., which is, therefore, the annual volume of delivery from underground sources. This volume of underground supply is equivalent to continuous uniform flow of 4.2 cu. ft. per second, which, on the basis of the above assumptions, would be the average volume of discharge from the underground supply.

The above figures constitute practically all the information that could be derived from the data in existence when the investigation of the power site first came up for consideration.

Owing to the existence of a market for power in the town of Picton, about 4 miles from the power site, it was considered necessary to investigate conditions in greater detail in order to ascertain definitely whether or not there existed in this power site a sufficient capacity to supply the requirements of the town, and in this connection the first step was to devise some means of accurately measuring the discharge out of the lake.

The lake is located at the top of a precipitous hill on the south shore of Picton Bay, the difference in level between the bay and the lake being ordinarily about 175 feet, the shores of the two bodies of water being not more than 600 feet apart. The water is carried from the lake through a small head gate and several hundred feet of riveted steel pipe to which the various wheels are connected at the foot of the hill. Owing to the leakage in the pipe and the absence of data relating to the volume of discharge through the wheels, it was necessary to use some other means of measuring the discharge from the lake. It was f und upon examination that the only practical means of doing this was to excavate a channel about 150 feet long from the lake into the bed of a small brook, which was evidently at one time the lake's natural outlet. This channel was excavated 12 ft. wide and to an average depth of 2 ft., and at the head of it was placed a sharp crested weir having a clear width of 12.01 feet. With the weir so placed it was possible to get the maximum head of 11½ inches on the crest, which was equivalent to a total discharge of about 37.6 cu. ft. per second. Discharge readings were taken on this weir at intervals of 15 minutes between 3.15 p.m. on Sept. 7th and 3.15 a.m. on Sept. 8, the work having been done on Sunday in order that the mills could be closed down and the head gate tightly closed. The readings taken over this 12 hour interval showed a total volume of 1,450,202 cu. ft. and it was also observed that during this 12 hour period the surface of the lake had dropped 1.56 inches. This drop in water level indicated that the measured outflow was composed of the underground discharge plus a volume of water corresponding to a drop in lake level of 1.56 inches.

During the course of the investigation an accurate stadia survey was made of the lake, and the area was found to be 9,352,000 sq. ft., or about 215 acres, so that 1.56 inches drawn off this area would mean a total volume of 1,215,760 cu. ft. which was discharged over the weir. As above mentioned, the discharge over the weir amounted to 1,450,202 cu. ft., so that the difference between these two totals, which amounts to 234,442 cu. ft., is a measure of the volume of supply from underground sources. This volume of flow delivered for a period of 12 hours is equivalent to a continuous discharge of about 5 cu. ft. per second, which is one of the results which the experiment was designed to supply.

At the conclusion of the above mentioned 12 hour period, the discharge was entirely shut off and it was found that for a subsequent 12 hour period the lake showed no tendency to fill up, the gauge readings being practically the same at the end of the second 12 hour period as at the beginning. In this connection, it is to be noted that the supply from which the lake was to be refilled had been ascertained to be 5 cu. ft. per second. With this volume of inflow it would require about 80.5 hours for the lake to fill to the original level, which would be at the rate of slightly less than ¼-in. every 12 hours. The slow rate of refilling, therefore, accounts to a certain extent for the absence of appreciable variation in level during the second 12 hour period,' but sufficient evidence was obtained in any event to prove that the recuperative capacity of the lake is very small.

From the above, therefore, it seems evident that while the lake appears to be supplied by springs having a very large volume of discharge, the dependable power capacity would not be more than 75 h.p., and that while the site is eminently suited to the purpose for which it is now utilized, it cannot be considered an adequate source of power for general industrial purposes.

It is, of course, possible that if the lake level could be materially lowered a corresponding increase of flow from the springs could be anticipated. The lowering of the lake level would tend to reduce the power capacity through the reduction in head, and this would, to a certain extent, effect the tendency to augment the power capacity through the result of the increase in flow, so that there would be what might be termed a critical head at which the maximum power capacity would be realized. This critical head could, of course, only be ascertained by very expensive experimental procedure. As an example of what the result might be, it might be assumed that by lowering the lake 20 feet the discharge from the springs might be tripled, so that there would be a discharge of 15 sec. ft. operating under a head of 145 feet. This would produce about 198 mechanical horse power. It would seem, therefore, that under no conditions would the site have sufficient power capacity to make it an attractive commercial proposition.

While the work preparatory to the experiment was being done the records were kept of variations of lake level. During the first week of operations, when the machine shop only was running, the water level remained practically constant, while during the second week when the machine shop and grist mill were both running, the water level dropped about two inches, notwithstanding the fact that heavy rains occurred during that interval. During the second week of the observations, therefore, the power required to run the mills absorbed about 1,500,000 cu. ft. from storage in addition to the normal inflow from the springs, plus the precipitation during that interval. This affords additional evidence of the small capacity of the source of underground supply.

TENSILE TESTS OF CONCRETE.

A series of tests on concrete specimens measuring 18in. long by 6in. square has recently been made in the engineering laboratory at Cornell University.

The specimens were of three different mixtures, the first a 1:2:4 mixture containing limestone crushed to pass a 1½-in. ring, the second a 1:2:4 mixture containing sandstone, crushed to pass a 2½-in. ring, and the third a 1:2½:5 mixture containing crushed sandstone similar to that of the second mixture.

In six tests the 1:2:4 limestone concrete showed an average tensile strength of 278lb. per square inch, the highest being 308lb. per square inch, and the lowest 253lb. per square inch.

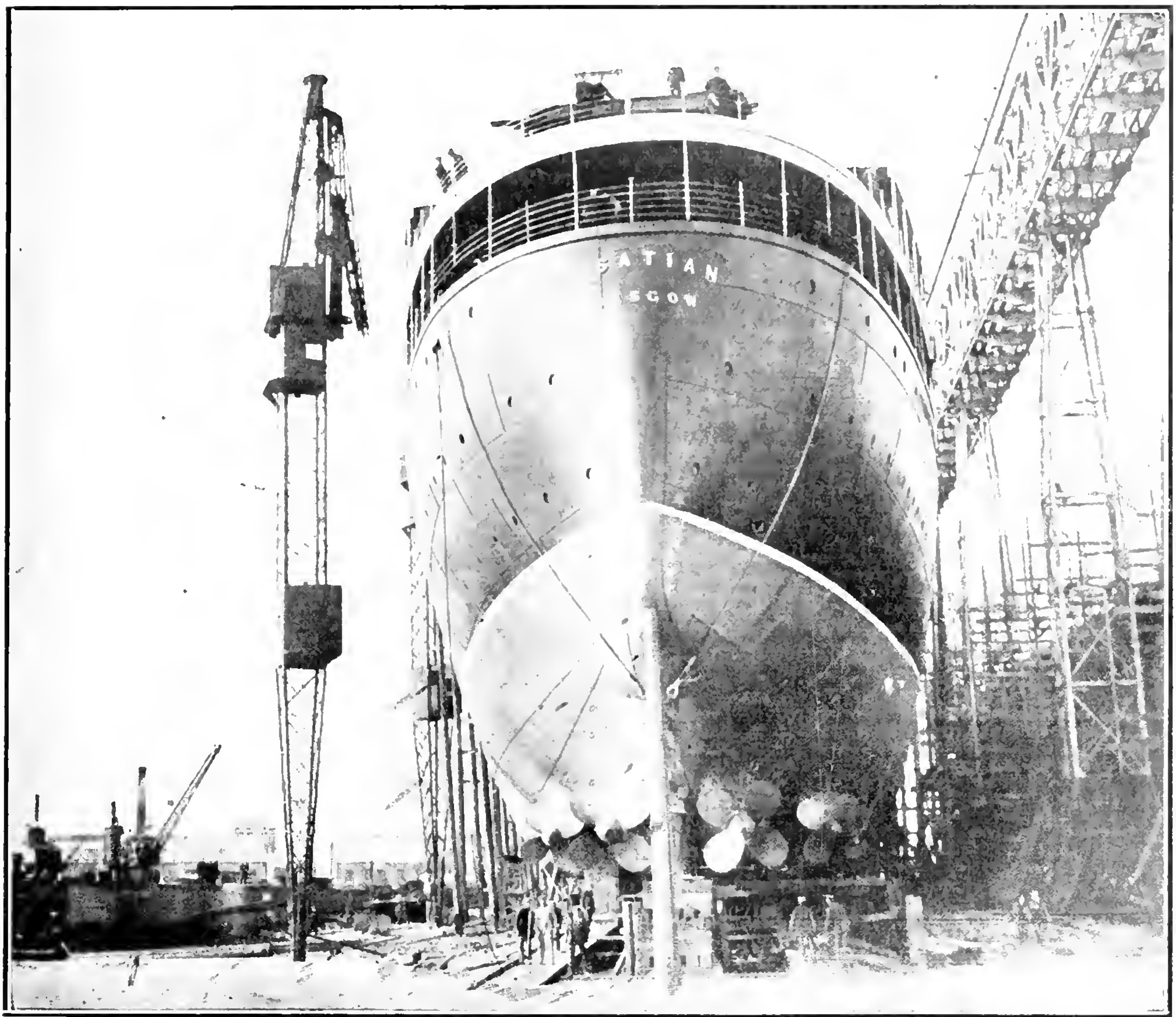
In nine tests, the 1:2:4 sandstone concrete showed an average tensile strength of 150lb. per square inch, the highest being 178lb. per square inch, and the lowest 128lb. per square inch.

In nine tests, the 1:2½:5 sandstone concrete showed an average tensile strength of 129lb. per square inch, the highest being 179lb. per square inch, and the lowest being 97lb. per square inch.

It is worthy of note that in many instances particles of sandstone were split in two in the plane of the fracture instead of breaking the bond with the mortar; this was particularly so in the case of the red sandstone, and illustrates the importance attaching to the selection of aggregates for employment in concrete work.

QUADRUPLE-SCREW TURBINE ALLAN LINER "ALSATIAN."

The Allans have been identified with the Canadian mail, passenger, and emigrant service for over ninety years. The line was originated by Captain Alexander Allan, a ship-owner-mariner of Glasgow, with a brigantine, named the "Hero," of 175 tons, her first duty being to carry stores to Wellington's army in the Peninsula. The service to Quebec was inaugurated by the "Jean" of corresponding size to the "Hero," in 1819, and was continued with a fleet of sailing ships of from 300 to 400 tons. Later, iron was adopted, and by 1845 the tonnage of the ships had risen to 710 tons. The limited the dimensions of steamers sailing up [illegible]rence. But improvements have been made within [illegible] few years, with the result that steamers of 16,000 and [illegible] tons now find no difficulty in reaching Montreal. The [illegible] fleet of the Allan Line is now represented by a quarter of [illegible] million tons gross, and there can be no doubt that the Allans not only in connection with their steamship service, but in other respects, have done much to develop Canada to that state of prosperity which in recent years has enabled the extension of railway lines to be profitably undertaken, and to stimulate the utilization of the natural resources of the enormous tract of rich grain growing soil. Internal development and attractive emigrant services across the ocean act



Stern View, Showing Propellers.

first steamer was placed in the service in 1854, to carry out the mail contract with the Canadian government. The steamers by 1858 had reached a tonnage of over 3,000 tons, with machinery of about 1,800 indicated horse-power, the service speed being 11 knots. Two notable ships on the list are the "Victorian" and the "Virginian," the first ships to trade in the Atlantic fitted with Parsons turbines. The advance in size and speed is the more remarkable as the condition of the channel between Quebec and Montreal greatly

and re-act upon each other, and thus, with the enterprise of steamship owners and of the Canadian railway companies, the Dominion must advance very rapidly. For his services to Canadian commerce, Mr. Hugh Allan was knighted by Queen Victoria in 1871. His son, Mr. H. Montagu Allan, was knighted by King Edward in 1904. A younger generation of the family now carry on the business of the founders of the line with marked success, Mr. Hugh A. Allan, in London, being the chairman of the company.

The first of the two new ships to be launched is named the "Alsatian," and has been constructed by Messrs. William Beardmore and Company, Limited. A sister ship, the "Cal-

---

* Abstract of portion of a description of "Alsatian" in Engineering.

garian," is being constructed by the Fairfield Shipbuilding and Engineering Company, Limited. The launch of the "Alsatian" recently was an unqualified success, and the occasion is of interest, as the vessel is the first to be launched by Mr. A. J. Campbell, who has taken up the management of the works, after having completed the organization of the Spanish naval establishments at Ferrol and Cartagena, as shipyard manager of the Sociedad Espanola de Construccion Naval.

The following are the principal particulars of the "Alsatian," which was designed, and was built from specifications, by Mr. A. M. Gordon, the naval architect of the Allan Line:

Length on L.W.L.	600 ft.
Length between perpendiculars	570 ft.
Breadth, moulded	72 ft.
Depth, moulded, to "D" deck	54 ft.
Gross tonnage (about)	18,000
Draught fully loaded	28 ft. 6 in.
Speed on trial, fully loaded	19 knots
S.H.P. on trial (about)	20,000
Speed on service	18 knots
Number of decks	8
Number of water-tight bulkheads	11
Number of first-class passengers, about	200
Number of second-class passengers, about	500
Number of third-class passengers, about	1,000
Number of officers and crew, etc.	500

A notable feature of the ship is the adoption of the cruiser stern. This arrangement confers several advantages. In the first place it is possible to get a greater displacement on a given length over-all, with corresponding increase in dead-weight, or, if the displacement be not increased, the lines may be fined down, so that the ship is more easily driven, with corresponding reduction in engine power. In the second place, the fuller water lines aft which are permissible with this type of stern ensure greater stability, especially at the deeper draughts. In the third place, it is probable that this form of stern tends to reduce the vibration due to propellers. This reduction in vibration is further ensured by the placing of the steering gear low down in the ship, immediately over the rudder-head, so that the weights in the after part are more directly water-borne than where the steering gear is placed on the poop-deck or immediately under it, with an overhanging counter. It is further claimed that the cruiser form of stern will make the ship more comfortable with a following sea, as there will be less tendency for her to "slam" on the waves. This form of stern also increases the deck space aft for the accommodation of passengers. The balanced rudder fitted with this type of stern considerably improves the manœuvring powers of the vessel, and being entirely immersed and protected by the long overhang aft, it is less liable to damage from ice, floating wreckage, or other obstructions, especially when the vessel is going astern. To some, however, the appearance of the ship aft may not appear so attractive as with the older form of stern with a counter of graceful lines, but this is largely due to the training of the eye.

The vessel is fitted with a double bottom all fore and aft, which is carried to the upper portion of the bilge—much higher than in some recent passenger ships. Bilge-keels of the Admiralty type are fitted for about half of the vessel's length amidships, to minimize rolling in heavy weather. The shell for about 80 feet from the stern has been doubled for a considerable extent both above and below the water-line, with a view to protecting the hull from ice, and the framing has also been specially strengthened for this purpose. The frame-spacing for the major portion of the length is 3 feet, being reduced gradually at the ends to 2 feet in the forward and after peaks. Hydraulic riveting was adopted for a considerable portion of the length amidships on the upper portion of the shell and stringers, where tensile and compressive stresses are likely to become greatest. Another feature in connection with this vessel is that no expansion joints are fitted in the boat or promenade decks forming the upper structure; these have been specially strengthened with a view to taking their portion of the stresses.

The vessel is designed so that she will have a positive G.M. of not less than 3 inches when fully equipped, in light condition; thus she may be moved in dock without the excessive use of water ballast. The vessel has been subdivided by eleven water-tight bulkheads, built up generally of plating 17/40 inch at their lowest part and 10/40 inch at their upper part, the average thickness being about 15/40 inch. The stiffeners of the lower portion consist of bulb angles 10 in. by 3½ in. by 22/40 in., and the upper portion of angles 4 in. by 3 in. by 12/40 in., with additional webs where required locally. All the water-tight bulkheads are carried up to "E" deck, and are therefore 9 feet above the maximum load line at the lowest point of the deck. Several of them, however, are carried to "D" deck, which is 8 feet higher. In addition to this, "F" deck is made water-tight at the forward and after ends of the vessel, beyond the machinery spaces. It is therefore calculated that the vessel will float with any four adjoining compartments open to the sea. Hitherto the Board of Trade have only required a vessel to be capable of remaining afloat with any two adjacent compartments open to the sea, so as to enable her to claim a reduction on the number of boats and other life-saving appliances to be carried; but in this vessel the aim has been to ensure her remaining afloat with four adjacent compartments open to the sea, which is far in excess of Board of Trade requirements, whilst the boats and life-saving appliances are also sufficient for every person on board, in accordance with the latest regulations. A further element of safety in this vessel is that all the vertical and horizontal sliding watertight doors which it was found necessary to fit in the watertight bulkheads below "E" deck are actuated hydraulically from the bridge on the Stone-Lloyd system, and provision is also made for working them independently at the doors or from "E" deck.

The vessel has eight decks, so constructed that they ensure the passengers of the three classes comfortable and pleasant quarters.

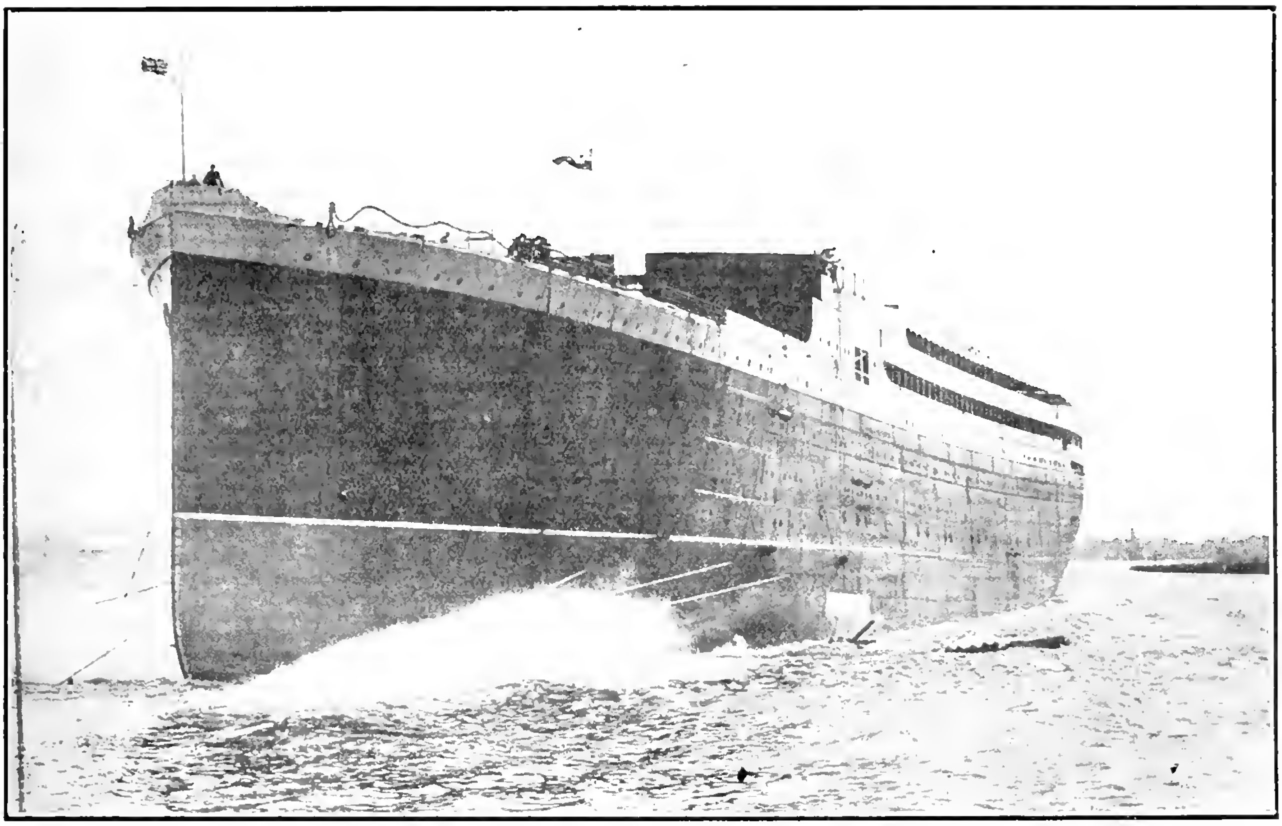
The gear for working the anchors consists of two separate and independent engines, each driving one cable-holder and one warping capstan, by Messrs. Napier Brothers, Glasgow. In addition there are four independent steam warping capstans, two on each side of the vessel. The engine for each capstan is placed in a separate house, and connected by shafting to the capstan, which is outside of it. The steering gear is by Messrs. Brown Brothers, and is of their latest steam steering-tiller type, with stand-by steering gear, the whole controlled by means of tele-motor gear.

There are ten steam-winches for working cargo, six of which are 8 in. by 12 in. (double), and four are 8 in. by 12 in. (single).

There are five electric lifts, one passenger lift, two for stores, and two for mails and baggage.

The main electrical generating plant consists of three steam-turbine-driven sets constructed by the British Westinghouse Electrical Company, each capable of giving a continuous output of 250 kw. at a pressure of 2 × 110 volts when running at 3,000 revolutions per minute. The turbines of the main generating sets are of the Westinghouse impulse type, the normal steam pressure being 150 lb. per sq. in.,

exhausting against a back pressure of 12 lb. gauge. The dynamos are of special construction, and are fitted with slip-rings on the shaft, to which tappings are taken from the armature windings, thence through brushes to the auto-transformers or balance-coils, the middle or neutral point of the balance-point constituting the mid-point of the direct-current circuit. A small emergency turbo-generator is also provided and placed in a separate compartment on the lower promenade "C" deck well above the load water-line of the vessel. This emergency set is also being manufactured by the British Westinghouse Company, and is of 20 kw. capacity at 110 volts. The main generators are placed on an elevated platform on the port side of the engine-room aft, and the main switchboard abaft of the machines on the bulkhead. The switchboard contains the three dynamo panels fitted with automatic circuits of massive design; voltmeters and ammeters of the moving coil type and shunt-regulators for each



Ship After Launching.

dynamo, there being in all thirty circuit-breakers and fourteen switches and fuses.

A special feature of the installation is the three-wire system, which, we believe, is now fitted for the first time on a large passenger ship. All heavy-power circuits are fed direct from the main switchboard at 220 volts pressure, the lighter and smaller motors being supplied from each side of the three-wire supply at 110 volts. From the switchboard heavy lead-covered cables are run on the port and starboard side to auxiliary switchboards placed in different compartments, and interconnected by heavy cables through circuit-breakers, forming complete ring mains round the ship, these being so arranged that in the event of a failure on any cable, a full supply is still obtained through the opposite feeders. Special precaution against heating has been made by carrying all feeders clear of the engine and boiler-room on the deck above these compartments. The total number of lamps installed throughout the ship is about 3,000, all of these being of the metal-filament type. Cables are also run from the main switchboard to the emergency dynamo, and for supplying a separate emergency circuit, a change-over switch being provided so that in case of accident a sufficient number of lamps can be kept lighted in the engine-rooms, boiler-rooms, and passenger accommodation, also on the boat deck should the main dynamos be shut down. Power is also available from this emergency dynamo for working the wireless installation and navigation lights.

The fittings in the public rooms and state-rooms are in keeping with the scheme of decoration, which is Jacobean. The domes of the lounge, smoke-room, and first-class entrances are arranged with concealed lamps above the colored glass, giving a pleasing effect. Electric clocks of the "Magneta" type are placed in the public rooms, entrances and chart-room, and all are controlled by a master clock. Pearson's automatic fire alarms are fitted throughout the vessel, with an indicator in the navigating-room. Thermostats, or heat detectors, are fixed in the different compartments. These can be set so as to give an alarm at a rise of 15 deg. Fahr., and can be limited for compensation to any predetermined temperature; means are also provided to allow each circuit to be tested for continuity by pressing a button at the indicator. In addition to the above there is a very complete system of fire alarm pushes or bells in corridors, etc., these being connected to indicators in the engine-room and navigating-bridge. Telephone instruments are fitted throughout the suite and special state-rooms are connected through a central exchange situated on the main deck. There is also a system of intercommunication telephones between the officers' cabins, and a similar system in the stewards' department, all of the Sterling Company's make.

For the ventilation of the ship an elaborate system of Ashwell and Nesbit's hot and cold air apparatus is fitted, the whole of the fans for this installation being electrically driven. Forty-six motors are used, which require over 150 horse-power.

For the navigation of the ship Graham's loud-speaking telephones are adopted on the navigating-bridge, communicating between forecastle, crow's-nest, docking bridge aft and chief engineer, Marconi room and engine-room and bow. A complete system of submarine signalling apparatus is arranged in the ship, and also a semaphore with Morse flashing-lamp and keys on a platform above the bridge. There is a navigation-light indicator of McGeoch's new pattern for masthead lights, bow lights, anchor and stern lamps.

As regards the electric appliances in the machinery department of the ship, there are four large forced-draught Howden-Laurence Scott combination fans for boiler-rooms, and twelve ventilating fans for stokeholds and engine-rooms, the total horse-power for these being 250. The three turbine lifting and turning motors have a total capacity of 15 horse-power.

In galleys, electrical power is used for the bakery machine, cooking-ovens, and there are motor-driven spits, knive-cleaners, dish-washers, potato-peelers, and freezing-machines, and a large number of electric hot plates throughout the dining-saloons and bars for keeping food and liquids warm during service; this gear requires about 60 horse-power.

The gymnasium is equipped with motor-driven appliances, consisting of one frictional machine, one Seiste's machine, and three horse exercise machines. Curling-tong heaters and fans are fitted in first-class cabins, also wing fans in the public rooms. A motor-driven printing-machine is also placed in the printing-room. The barbers' shops are provided with the latest type of electrically driven hair-brushes, hair-dyers, and massage apparatus; each machine is fed from a socket placed in a convenient position to the chair, no overhead shafting being required.

The steam whistle is the Willett Bruce pattern, and is worked by a small motor and solenoid enclosed in a water-tight case placed in a convenient position near the whistle. Provision is made for blowing by hand-cord in the ordinary way, and the whistle can be operated by the three switches placed port, starboard, and amidships on the captain's bridge, these are so arranged that either "time control" or "signal control" can be made.

The propelling machinery consists of Parsons' compound steam-turbines arranged in series on four shafts, and including one high-pressure, one intermediate, and two low-pressure turbines. Two astern turbines, each with impulse and reaction blading, are incorporated with the low-pressure turbines, which latter drive the inner lines of shafting. These, therefore, are alone used for manœuvring. Steam from the boilers may pass direct to each turbine, and by a suitable arrangement of pipes and valves, any shaft may be operated independently of the others; but normally the steam will pass in sequence through high, intermediate, and both low-pressure turbines. With this arrangement of machinery, better economy is expected than with the usual four-shaft parallel arrangement.

The turbine casings are of cast iron, and the drums, dummies, spindle, wheels, and shafting are of forged steel made at the Parkhead Works of the builders. Forced lubrication is fitted throughout for the main bearings, adjusting-blocks, and plummer blocks, and the arrangements include four Weir's lubricating oil-pumps, two Carruthers' water service pumps, with the necessary oil-coolers, drain, and reserve-tanks.

The condensing plant is fitted in a separate water-tight compartment immediately aft of the engine-room, and consists of two main condensers of the "Uniflux" type, in conjunction with two dual air-pumps, together capable of carrying and maintaining a high vacuum even in summer, when the temperature of sea-water approaches 75 deg. Fahr. Four centrifugal circulating-pumps are provided for supplying the necessary water to the condensers. The air-pumps discharge to filters of the gravitation type, through which the feed-water flows to large float-control tanks. These control-tanks are arranged about the middle line of the vessel, and suctions are provided for the main auxiliary feed pumps. A large feed-heater of the surface type takes all the exhaust steam from the auxiliary machinery, including the turbine-driven electric generators, and is drained to the float-tanks through the filter. Any surplus exhaust steam may be passed to the turbines. With this utilization of the exhaust steam for heating the feed-water for the boilers great economy in working is expected. Other auxiliaries include pumps for bilge, sanitary, ballast, hot and cold fresh water, hot and cold salt water, and ash-ejector purposes. It should be noted that the sanitary pumps are of the rotary type, driven by electric motors, thus eliminating noise and shocks.

Steam at a working pressure of 200 lb. per sq. in. is supplied by six double-ended and four single-ended boilers of the cylindrical type, working under Howden's system of forced draught, and arranged in two compartments. There are four forced-draught fans, placed on deck above the boilers, and driven by electric motors. Ash-ejectors and ash-hoists are fitted in each compartment, and special arrangements have been made for ventilation of boiler-rooms by electric fans of the pressure type.

The vessel, boilers, and machinery have been built under special survey to British Corporation Rules to enable her to class B.S. with that society, and she will also comply with latest Board of Trade requirements and Canadian immigration laws.

TEST TO DESTRUCTION OF BRICK PIERS FOUR FEET SQUARE AND TWELVE FEET HIGH.

The testing of two brick piers of unusual size is described by Maj. J. E. Howard, Engineer Physicist, Bureau of Standards, in a paper before the National Brick Manufacturers' Association. We have redrawn the diagram showing the test results and with it publish here the portion of the paper relating specifically to the tests. The piers were about 4 ft. square by 12 ft. high, weighing a little over 13 tons each. They were built of common, hard burnt, wire cut building brick from one of the yards of Messrs. Booth & Flinn, Pittsburg. One pier was laid in 1:1 cement mortar, the other in 1:3 lime mortar.

The brick were selected with a view of laying a pier which would display a crushing strength of about 3,000 lbs. per square inch when laid in cement mortar, provided this

Table I.

Pier laid in	Dimensions. Height.	Cross-section.		Sectional area, sq. ins.	Average thickness of joints.	First crack. Total lbs.	Total lbs.	Ultimate strength. Lbs. per sq. in.
cement mortar	12 ft.	47.5 ins.	47.5 ins.	2,256	5-16 ins.	4,737,000	6,580,000	2,917
lime mortar	12 ft.	47.5 ins.	47.5 ins.	2,256	5-16 ins.	676,800	1,710,000	757

pier of nearly 190 cu. ft. volume had a strength per square inch of cross sectional area proportional to one of 8 cu. ft. volume. The pier actually displayed an ultimate strength of 2,917 lbs. per square inch, indicating substantially the same strength in each size. Similarly the pier which was laid in lime mortar was expected to have an ultimate strength somewhat less than 900 lbs. per square inch. It failed at 757 lbs. per square inch.

Owing to their great size the piers were built in the testing machine, where they seasoned until the time of testing. The test of the cement mortar pier was completed when four weeks and three days old. Ten gauged lengths in all of 20 ins. length each were established on the four sides, the extremities of which were defined by small metal plugs cemented in the bricks. As loads were applied and advanced the compression of the pier was measured on these 20-in. lengths by means of a strain gauge, in practically the same manner as thermal effects on cement filled brick pavements are being observed by means of that instrument. The compression of the lime mortar pier was measured when it was 25 days old.

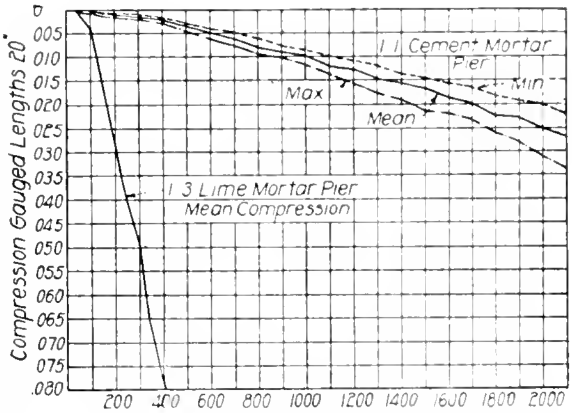


Fig. 1.—Curves Showing Relative Compressibility of Brick Laid in Cement and Brick.

The results of the tests were as shown by Table I.

In failing, along the middle of their heights, the sides opened laterally. Frictional resistance at the ends, between the brickwork and the platforms of the testing machine, strengthened the piers against lateral deformation and probably influenced the pyramidal shapes assumed after rupture. The manner of failure of these large piers was the same as that witnessed in piers of smaller dimensions.

Diagrams are presented to illustrate the behavior of these piers during test and at their ultimate strength. Figure 1 shows the compression curves of the two piers as loads were successively applied. The pronounced difference is in their rate of compressibility is well indicated. This difference is, of course, due to the difference in the mortars used. These curves represent the total compression of the brickwork, which in the case of the lime mortar pier was chiefly permanent set. But that of the cement mortar pier at 1,000 lbs. load was about one-third permanent set and two-thirds elastic compression, or, stated differently, the cement mortar pier would recover about two-thirds of the observed compression upon release of load.

Three curves are given for the cement mortar pier, one representing the mean compression, one representing the minimum compression of the several gauged lengths and one gauged length which displayed the maximum compression. Since the ends of the pier were in contact with and were moved by the rigid platforms of the testing machine this difference in the amount of compression on the several gauged lengths, which were established along the middle of the height of the pier, represents unequal compression locally, and would occasion bending stresses in the bricks and lead to the formation of transverse fractures.

HYDRO-ELECTRIC POSSIBILITIES OF THE MAITLAND RIVER, ONTARIO.

In June of 1912, a report on the power possibilities of the Maitland River was made to the Hydro-Electric Commission of Ontario by Mr. H. G. Acres, hydraulic engineer to the commission. This report, which is incorporated in the last annual report of the commission, just published, gives a considerable amount of data regarding the hydrology of the stream, together with an analysis of the possibilities of commercial development. The report is given herewith in full:

The natural source of power for the county of Huron is the Maitland River, which rises on the height of land between Lake Erie and Georgian Bay, and flows into Lake Huron through the town of Goderich. The watershed of this river is about 950 square miles in extent, and is largely drained and deforested. As a result, the natural flow characteristics have been destroyed, and the watershed of the Maitland River, in common with the watersheds of other rivers in the southwestern peninsula, has an uncontrolled run-off which produces heavy spring freshets, and a consequent low discharge during the late summer and early autumn periods.

The abnormal flow characteristics of the Maitland River to a large extent discount its value as a source of power, the more so by reason of the fact that its watershed is almost entirely lacking in natural storage basins. The country throughout the whole area is cleared and for the most part cultivated, so that the land damages and construction costs in connection with the establishment of remedial works of sufficient magnitude to adequately offset the effects of drainage, cultivation and deforestration would be prohibitive. In view of this fact, the power possibilities of the Maitland River, considered as an independent source of continuous power, can only be discussed on the basis of minimum flow, in conjunction with such advantages as can be derived from local pondage.

The total drop of the Maitland River from headwaters to mouth is approximately 900 feet, but the topography of the watershed is such that no natural heads of any consequence exist, the gradient of the river-bed being fairly uniform and the average velocity high. As a result, power can only be developed by diversion or by the creation of an artificial head, or by a combination of both methods. This condition, in conjunction with the poor run-off regulation, will tend to make power development expensive, and to increase the annual cost of power.

The above general facts and the general conclusions deduced therefrom, comprised practically the sum total of all hydraulic data in connection with the Maitland River which could be safely used when the Huron County scheme first became a definite issue. The proper consideration of the scheme, therefore, necessitated at the outset a systematic investigation of the flow characteristics of the Maitland River. Owing to the desire of the county authorities to have a report at the earliest possible date, it was decided to carry on the hydraulic investigations for one year only, the understanding being that any conclusions arrived at by the end of that period should not be considered as final, but merely as indicating reasonable possibilities. The extent to which this end was attained will now be considered.

Early in May, 1911, a gauging station was established at Ben Millar, and since that date monthly measurements of flow have been made, and in connection with these measurements daily records of level were also obtained.

The records obtained up to the present time are tabulated hereunder:—

Date of measurement.	Discharge. Cu. ft. per sec.	Water level.	Electric h.p. per foot of head. Horse-power.
May 19, 1911	979	14.27	82
June 14, 1911	549	13.80	46
July 20, 1911	305	13.60	25
August 11, 1911	170	13.37	14
September 18, 1911	172	13.39	14
October 16, 1911	257	13.55	21
November 20, 1911	4,068	15.34	340
December 22, 1911	1,280	14.30	107
January 27, 1912	752	Ice	63
February 29, 1912	506	Ice	42
March 28, 1912	2,116	Ice	176
April 6, 1912	41,000	20.26	3,420
April 7, 1912	65,000	21.60	5,420
April 26, 1912	1,437	14.40	120
May 30, 1912	5,815	16.13	485
Estimated extreme minimum on Aug. 30, 1911	120	13.18	10

The last item in the above table is inserted by reason of the fact that there was no actual measurement of flow taken when the water-level reached its lowest stage of 13.18 at Ben Millar, as evidenced by the daily records. The estimated discharge of 120 cubic feet per second is considered to be a generous one and is to be considered the minimum volume of flow so far recorded.

The flow characteristics of the river during the term covered by these records may be summarized as follows:—

(1) The minimum run-off of the watershed was about .125 cubic feet per second per square mile.

(2) The maximum run-off of the watershed was about 68 cubic feet per second per square mile.

(3) The ratio of minimum to maximum flow was at 1 to 543.

(4) The low stages of flow occurred during the months of July, August, September and October.

(5) The intermediate stages of flow occurred during the months of November, December, January, February, March and June.

(6) The high stages of flow occurred during the months of April and May.

These records also indicate:—

(1) That the river is extremely sensitive to the effects of rain-fall.

(2) That the river is seriously deficient in ground storage capacity.

(3) That deforestation, cultivation and drainage have so accelerated the run-off that the ground storage of the watershed can never be filled to its natural capacity. The falling off in discharge from 65,000 sec. ft. on April 7th to 1,437 sec. ft. on April 27th plainly indicated the existence of this condition.

The records so far obtained seem to indicate, therefore, that the discharge of the Maitland is mainly dependent upon surface run-off, and the power capacity of the river from month to month will vary almost in proportion to the monthly precipitation on the tributary watershed. This contention is borne out by the evidence of the May discharge. On May 19, 1911, there was 82 h.p. per foot of head at Ben Millar, with the May precipitation slightly below normal. On May 30, 1912, there was 485 h.p. per foot of head at Ben Millar, with the May precipitation 300 per cent. above normal.

This intimate relation between rain-fall and power capacity indicated the necessity of determining what relation the monthly precipitation during the year covered by the records bore to that of previous years, and precipitation records from all meteorological stations located in or adjacent to the Maitland River watershed were obtained with this object in view. These records proved to be so disconnected and otherwise unsatisfactory that an exhaustive analysis of the same would have been useless. The figures relating to precipitation have, therefore, a low degree of accuracy, and are submitted only because of the impossibility of procuring more reliable data.

The figures in the table below were compiled from precipitation records taken at Goderich for 36 years, at Clinton for 8 years, at Mount Forest for 7 years, at Stratford for 16 years, at Lucknow for 27 years, and at Listowel for 10 years. The first column contains the average of all records of monthly precipitation to date, and the second column contains the precipitation for the corresponding months during which the flow characteristics of the Maitland were being investigated.

General average monthly precipitation for all years.		Monthly precipitation during months of measurement.	Difference Above average.	Difference Below average.
Jan.	3.55 inches	(1912) 4.70 inches	1.15	....
Feb.	2.95 "	(1912) 2.12 "	....	0.83
March	2.62 "	(1912) 1.59 "	....	1.03
April	2.15 "	(1912) 2.10 "	....	0.05
May	2.93 "	(1911) 2.71 "	....	0.22
June	2.91 "	(1911) 2.02 "	....	0.89
July	2.91 "	(1911) 1.90 "	....	1.01
Aug.	2.47 "	(1911) 2.59 "	0.12	....
Sept.	2.86 "	(1911) 3.71 "	.85	....
Oct.	3.39 "	(1911) 4.45 "	1.06	....
Nov.	3.49 "	(1911) 4.33 "	.84	....
Dec.	3.48 "	(1911) 2.13 "	....	1.35

It will seem from the above that the monthly precipitation during the year of investigation fell below the general average during the months of February, March, April, May, June, July and December, and was above the general average during the months of August, September, October, November and January.

While, as previously stated, the reliability of the precipitation data is questionable, several deductions can be drawn from the above figures which have a certain value.

These deductions may be itemized as follows:

1. The average precipitation for the three winter months of December, January and February from the above table is 9.98 inches. The precipitation for this period in 1910-11 was 9.46 inches, or 0.52 inches below the average. The precipitation for the corresponding period in 1911-12 was 8.95 inches or 1.03 inches below the average. It is to be inferred from this that there was a greater volume of spring run-off during the spring of 1911 than there was in the spring of 1912. This condition should reasonably be expected to produce a greater summer flow in 1911 than in 1912, on account of the fuller replenishment of ground storage.

2. The average precipitation for the three months of March, April and May is 7.70 inches. The precipitation for this period during 1911 was 8.21 inches, and for the same period in 1912 was 10.54 inches, being therefore 0.51 inches above the average for 1911, and 2.84 inches above the average for 1912. Under these conditions the tendency would be to produce a spring discharge in the Maitland slightly above

the average in 1911, and considerably above the average in 1912. This should also have a tendency to make the summer flow for 1911 less than the summer flow for 1912, but slightly more than the average.

3. The average precipitation for the three summer months of June, July and August is 8.29 inches. The precipitation for the summer months of 1911 was 6.51 inches, or 1.78 inches below the average. The tendency would, therefore, be for the production of a summer discharge below the average during 1911.

4. The average precipitation for the three autumn months of September, October and November is 9.74 inches. The precipitation during the autumn months of 1911 was 12.49 inches or 2.75 inches above the average. The tendency of this condition would be to produce an autumn discharge greater than the average in 1911, and also to produce a discharge greater than the normal during the winter months of 1911, and 1912.

Applying these deductions to the flow characteristics found by measurement during the years 1911 and 1912, the following conclusions are derived:—

1. The winter precipitation for 1910-11 was slightly less than the average but greater than the winter precipitation for 1912, the tendency being therefore to produce a summer flow in 1911 slightly above the average, and greater than the summer flow for 1912.

2. The spring precipitation for 1911 was slightly greater than the average but much less than the spring precipitation for 1912, the tendency being, therefore, to produce a spring run-off and consequently a summer flow, slightly above the average in 1911, but less than would obtain in 1912.

3. The summer precipitation for 1911 was considerably below the average, the tendency therefore being to produce a summer flow less than the average.

4. The autumn precipitation for 1911 was considerably above the average, the tendency being to produce an autumn and winter flow greater than the average.

As regards summer flow in 1911, we have therefore two factors, the winter and spring precipitation and the spring run-off tending to make it a maximum through the effect of ground storage, and one factor, the summer precipitation, tending to make it a minimum by reason of a summer run-off which was below the average. Inasmuch as surface flow is assumed to be the governing factor as regards the discharge of the Maitland River, it may be reasonably stated that the summer discharge for 1911 was really below the average, and also that the summer discharge for 1912 may be expected to be greater tban that of 1911 and possible above the average.

In the matter of autumn and winter flow, that shown by measurement during 1911 and 1912 is probably much greater than can ordinarily be expected, as the autumn precipitation was so much in excess of the average. Smaller values for discharge are to be anticipated during the coming autumn and winter if, as seems probable, the precipitation more closely approaches the average.

To conclude this portion of the argument it may be said that, as regards the flow characteristics of the Maitland River, the outstanding features are, first, its sensitiveness to the effects of rain-fall, and, secondly, its dependence upon surface run-off as against ground storage. Therefore, while the conclusions above set forth may cover the general behavior of the river over a cycle of years, the occurrence of abnormal or unusual precipitation phenomena during some particular season may give rise to temporary conditions of flow, the nature of which it is not now possible to anticipate.

The initial decision that the Black Hole power-site was the best suited to the requirements of the commission and the county of Huron is amply justified by the results of the subsequent investigation. The minimum capacity of 10 h.p. per foot of head proves the necessity for developing under the highest possible head that topographical conditions will permit and that capital cost will justify, and also for choosing a site providing the best facilities for pondage in order to make peak load and daily storage capacity a maximum. The Black Hole site, with an operating head of 80 feet, and something over 700 acres of pondage obtainable, fulfils the required conditions more satisfactorily than any other possible location on the lower river and has been considered to the exclusion of all others.

Referring back to the table of discharge measurements, the power capacity of the Black Hole site, under an 80-foot head, upon the various dates of flow measurement, would be as follows:

Date of measurement.	Continuous 24-hour power capacity.	Probable combined 10-hour and 24-hour capacity.
May 19, 1911	6,560 E.H.P.	10,000 E.H.P.
June 14, 1911	3,680 "	5,800 "
July 20, 1911	2,000 "	3,200 "
Aug. 11, 1911	1,120 "	1,800 "
Aug. 30, 1911 (min.)..	800 "	1,200 "
Sept. 18, 1911	1,120 "	1,680 "
Oct. 16, 1911	1,680 "	2,400 "
Nov. 20, 1911	27,200 "	38,000 "
Dec. 22, 1911	8,560 "	12,000 "
Jan. 27, 1912	5,040 "	7,100 "
Feb. 29, 1912	3,360 "	4,700 "
Mar. 28, 1912	14,080 "	21,000 "
April 26, 1912	9,600 "	15,400 "
May 30, 1912	38,800 "	62,000 "

Considering the above figures in connection with the conclusions derived from the study of precipitation, the following general statements with regard to power capacity would seem justifiable:

1. The spring flow will, under all circumstances, produce power in excess of economic installed capacity.

2. The summer flow was probably close to the minimum during 1911 and a larger summer power capacity may be anticipated under average conditions.

3. The autumn precipitation and late autumn flow was considerably in excess of the average, so that the power capacities established by measurement during the autumn and winter of 1911-12 cannot be considered normal, and conditions much less favorable should frequently obtain.

Considering the power capacities in connection with the market demand, it is evident that even under average conditions, the summer power capacity of the Black Hole site will not be sufficient to carry the Huron county load, so that some portion of it will always have to be carried by Niagara during the summer season, and probably at times in the early autumn. Also while the autumn and winter capacity may at all times be sufficient to carry the Huron county load, it is by no means certain that sufficient surplus capacity will be available to supply auxiliary power to the Niagara system. As the Maitland River will be obliged to furnish power to the Niagara system during the autumn and winter months to compensate for power obtained from Niagara during the summer, the serious nature of this condition is evident; for unless the Maitland River can furnish auxiliary power during the peak load period when it is required, the summer power supplied by the Niagara system will have to be paid for by the county of Huron.

The projected scheme of development at the Black Hole involves the creation of an artificial head and also a diver-

sion. It is proposed to build a dam of sufficient height to back the water up to Ben Millar bridge and to further increase the head by diverting the flow across the neck of a sharp bend in the river. The additional head obtained by this diversion will be at 5 to 15 feet, depending upon the relative locations of the dam and power-house, and the total average head available would be about 80 feet.

The largest item of capital cost in connection with this development is the dam construction, and before the flow characteristics of the river had been investigated it was thought that earth fill construction could be used for the main dam, but the abnormal flood flow conditions evidenced by this spring's measurements demonstrated the practical impossibility of utilizing this type of construction at the Black Hole. It was therefore necessary to largely increase such preliminary estimates as had been made to provide for a masonry dam, and the hollow reinforced type of construction was adopted as being the cheapest and most economical after giving proper consideration to safe and efficient handling of ice and flood-water.

In a general way it may be said that the conditions relative to development at the Black Hole could not well be more unfavorable, as the low water power conditions are such as to make the revenue-producing power capacities very small, while the flood conditions are such as to call for an abnormally heavy capital expenditure for dam construction and permanent works. The annual cost of generated power is therefore affected by reason of the fact that the revenue from power generated at low stages of flow must be sufficient to cover the heavy capital charges and maintenance costs arising out of the necessity for handling an abnormal flood discharge.

Two estimates of the cost of development at the Black Hole have been made, one for 2,000 h.p., and one for 6,000 h.p. installed capacity. The 2,000 h.p. estimate represents the cost of developing the Black Hole site, as an independent source of power, to the limit of dependable 10-hour capacity. The 6,000 h.p. estimate provides surplus installed capacity for the purpose of using the higher stages of flow to supply auxiliary power to the Niagara system.

The 2,000 h.p. estimate shows a capital cost of $587,000, and a total annual charge of $45,500. The 6,000 h.p. estimate shows a capital cost of $637,000 and a total annual charge of $51,500. Considering these figures in connection with the statements made above as to the effect of a low power capacity, combined with a heavy flood discharge, upon cost, it is interesting to note:—

1. In the 2,000 h.p. estimate, the dam construction amounts to 63 per cent. of the total capital cost, and the annual charges against dam construction alone amount to 51 per cent. of the total annual charges.

2. In the 2,000 h.p. estimate, the interest and sinking fund charges amount to 75 per cent. of the total annual charges.

3. In the 6,000 h.p. estimate, the dam construction amounts to 58 per cent. of the total capital cost, and the annual charges against dam construction alone amount to 45 per cent. of the total annual charges.

4. In the 6,000 h.p. estimate, the interest and sinking fund charges amount to 71 per cent. of the total annual charges.

It is evident from the above figures that the annual cost of generated power at the Black Hole will be high as long as the interest and sink fund continues to be an annual liability, the more so because the revenue from such continuous power as can be generated under conditions of minimum flow will always have to carry the bulk of the annual charge against the development.

FREIGHT RATES BY WATER

The plans of the department of railways and canals for ascertaining the average rate per ton per mile on the inland waters of Canada involved the recording of the freight rates on each ship's report filed at the various canal offices. As an alternative those operators who wished to do so were permitted to send a monthly statement to Ottawa of tonnage, mileage and gross freight earnings. Ship owners were also required to send in at the close of the season a report showing:—Total tons carried, total ton mileage of loaded vessels, gross receipts from freight. On the whole, and having regard to the difficulties which are inseparable from the inauguration of new undertakings of that character, the results obtained during the past year the first of the operations of the plans were satisfactory. For example, out of a net Canadian tonnage of 6,942,278, definite information was received with regard to the mileage and freight earnings on 6,292,661 tons. St. Peters and St. Andrews canals were left out of the scheme for the year 1912, and they accounted for 170,358 tons; so that the actual net Canadian tonnage affected was 6,771,920. Returns were thus received in relation to 93 per cent. of Canadian business. These returns covered all classes of traffic, and it might reasonably be assumed that had every ton been accounted for, the result would not have been altered.

The Canadian returns applied to 6,292,661 tons of freight, to 3,286,187,160 ton miles, and to gross freight earnings amounting to $6,378,893.43.

From United States shipping companies reports were received covering 26,030,661 tons, out of a total net tonnage of 36,840,812. These reports had reference to all classes of commodities, and were thoroughly typical of the whole business on inland waters of Canada. It may be confidently asserted that absolutely complete returns would not have materially affected the final calculation of the average rate per ton per mile. The number of ton miles accounted for amounted to 21,799,392,809, and the gross earnings on United States freight to $14,617,368.60.

Using the factors which have been indicated—the ton mileage and the gross earnings from freight—the results are as follows:—

Canadian traffic:—

Average rate per ton ....91. 04 cents.
" " per mile .... 0.194 "

United States traffic:—

Average rate per ton ....50. 62 cents.
" " per mile .... 0.067 "

Without an explanation, the difference between the Canadian and United States rate per ton per mile will not be understood. Of the 36,840,812 tons of United States traffic through the canals of Canada in 1912, no less than 31,134,251 tons, or nearly 85 per cent., consisted of iron ore. Upbound coal accounted for a further 2,945,441 tons, or 8 per cent. In fact, if iron and coal were eliminated from the total account, the volume of Canadian traffic would exceed that of tne United States.

The transportation of iron ore and coal is a special feature of the trade of the Great Lakes. Most of the ore is carried by the vessels of the Pittsburg Steamship Company, and the rate in 1912 was 55 cents per ton from the head of Lake Superior to ports on Lake Erie. These vessels are owned and operated by the iron interests of Pittsburg, and do not carry other commodities than ore and coal—ore down and coal up. For this upbound coal, without regard to ownership of the vessels, the rate last year was 30 cents per ton. Thus, while wheat was being carried to Buffalo at as high a rate as 2.616 cents per ton per mile, iron ore was passing over the same route at .063. Coal was being moved upward at the still lower rate

of .046 per ton per mile. In a word, any analysis of freight rates on the inland waters of Canada would be misleading which failed to recognize, and to separate for special treatment, this overwhelming movement of ore and coal under the conditions indicated.

Special care was taken during the year to ascertain with accuracy the rates which were charged on waterborne wheat. The facts in that regard were carefully tabulated. They yielded the following results:—

Fort William to Buffalo, per ton per mile, .103 cent; per bushel, 2.863 cent.

Fort William to Georgian Bay, per ton per mile, .163 cent; per bushel, 2.629 cent.

Fort William to other Canadian ports, per ton per mile, .115 cent; per bushel, 2.384 cent.

Fort William to Montreal, per ton mile, .160 cent; per bushel, 5.774 cent.

The lowest rate prevailed in May, and the highest in December.

There was not any wheat actually brought down from Fort William to Montreal in December; and the rates are for November. The largest volume of wheat moved between Fort William and Montreal occurred in October, when the average rates were .184 per ton mile and 6.149 cents per bushel. For the same month the rates from Fort William to Buffalo were .084 per ton per mile, and 2.259 cents per bushel. The maximum rate of the season between Fort William and Montreal was in effect in November, and was 8 cents per bushel.

To measure the conditions which influenced the movement of Canadian wheat to Montreal or Buffalo, it is necessary to know the freight rate on wheat from Buffalo to the Atlantic seaboard during 1912. It was officially ascertained from the Buffalo chamber of commerce, under date of 14th February, 1913, that these rates per bushel were: May to end of September, on lake wheat for export, 4½ cents; in October 5½ cents; after fifteenth November, six cents.

Thus, the all water rate from Fort William to Montreal in May was 5.444 cents per bushel, and the combined water and rail rate from Fort William to the American seaboard (say New York) was 7.219 cents. In November, the water rate from Fort William to Montreal was 7.129 cents per bushel, and the combined water and rail rate from Fort William to the United States seaboard, via Buffalo, was 8.616 cents. The apparent difference in favor of Montreal was 1.765 cents per bushel in May, and 1.487 cents in November, so far as the rates of freight were concerned.

There remains to be presented the facts with respect to traffic by way of Fort William and Georgian Bay ports. The average rate for the season was 2.629 cents per bushel. It was officially ascertained that the rail rates from Georgian Bay to Montreal were as follows:—

	Per Bushel.
Canadian Pacific Railway	6 cents.
Grand Trunk Railway, January 1st to June 30th	5 cents.
Grand Trunk Railway, July 1st to September 30th	4 cents.
Grand Trunk Railway, October 1st to December 31st	5 cents.

Speaking broadly, it might be assumed that the combined water and rail rate is adjusted to practically equal the all-water rate.

Among the causes which operate to divert a large percentage of Canadian wheat from Canadian to United States channels despite the lower transportation cost are:—The availability of ocean tonnage at New York, the consideration of time in making delivery at foreign ports, and the rates of marine insurance. It is obvious that these causes must have continued to operate effectively in 1912.

The question is frequently, and quite naturally, asked: How do freight rates by water compare with freight rates by rail? This question will never be fully and satisfactorily answered until carriers by water are required to report in precisely the way railways are asked to do.

This year, for the first time, accurate information has been obtained with regard to the average rate per ton per mile on the waterborne traffic of the Great Lakes. That rate, so far as Canadian business was concerned, was found to be .194 cent. It is pointed out, however, that this rate does not take cognizance of the special conditions under which traffic on the inland waters of Canada is conducted, and that the contribution of government should be taken into the reckoning. There is pertinency in such a contention. It would seem, at all events, to be proper to include the interest charge on the capital cost of the canals and the annual outlay by government for up-keep. The facts in that regard are definitely known. This plan omits all expenditures for harbors, lighthouses, dredging, buoying, etc., which might be included; but, whether they should be included or not, the matter is ruled out for the time being by reason of the fact that the sum of such expenditures is not definitely known.

HARDENING ARMOR PLATE BY WELDING.

Sheffield steel experts are awaiting with considerable interest further information concerning tests, which, it is stated, have been applied with some success to armor plates manufactured by a new process which, the inventor claims, renders them capable of resisting projectiles of the highest power.

The inventor is William Henry Worrall, of Sheffield. He states that the new armor plate does not at all rely upon any new ingredient for its increased resisting power, but that this is obtained as the result of a different process of hardening, largely secured by the welding or bonding of four or six sheets of metal into one plate, instead of molding the plate as a whole in one ingot. The main object is to effect a thorough homogeneous hardness. This, it is said, will permit of ironclads being as efficiently protected with much thinner and lighter plates than is at present the case.

Several experts express some doubt as to whether the welding of a number of plates contributes to greater homogeneity. They all agree that experiments conducted on somewhat similar lines have not hitherto been attended with success. Dr. J. O. Arnold, F.R.S., professor of metallurgy at Sheffield University, said:

"Practical experience in armor plate manufacture is that you must have the face sufficiently hard and with sufficient depth of hardness to smash up a shell. No reliable estimate can be formed of the value of a plate until it has been drastically tested by the admiralty, under standard conditions. So far as I know there is only one plate of this so-called bonded process of manufacture which has been so tested, and that was a failure. There is a new system of manufacturing armor plates, at present in the experimental stage, which consists of welding a face of high-speed steel on to the relative soft backing of the plate. This has been done with some measure of success, but the ultimate value of the plate can only be determined by an admiralty test. I see it is claimed that Mr. Worrall's plate has withstood a fourteen-inch shell. If that is so, it must have been an admiralty test, because I do not think any private firms are equipped with such a gun.

COAST TO COAST.

Montreal, Que.—The Great North Western Telegraph Company will install in June next between this city and Toronto the Wheatstone high-speed automatic apparatus, which will transmit 400 words a minute, or 24,000 an hour, as compared with 5,000, the record for Morse operators under quadruple operation. The system has been used extensively by the British post-office and the Western Union Telegraph Company, of the United States. Mr L. S. Hume, local manager, recently stated that no reduction of operators would be made on account of the Wheatstone installation. At present, he stated, the growing demands of patrons of the company, both in Montreal and in Canada generally, required increased facilities for handling telegrams. The new arrangement will enable the Great North Western to better cope with their largely increased business. It is learned that one circuit of the new installation will require a staff of twenty-six persons to properly operate one wire only. Three operators will look after a perforating electrical machine run from a typewriter keyboard. A punched tape, which is fed by a "transmitter" working at high speed, where the signals are transferred to a tape by a "receiver." The tape is then handed to typewriter operators, who copy them.

Ottawa, Ont.—Mr. W. A. Legge, the British engineer sent here by Sir Alexander Binnie, has started work in connection with the proposed water supply from the Gatineau lakes. He is first getting the information which may be gleaned from plans and reports in the city engineer's office and from information given Dr. King by the Government parties of surveyors. About the end of this week he will go to the lake district and take charge. There are two Government parties out. One is working around Little Whitefish, Thirty One Mile and Pemichangaw Lakes, and the other is taking levels between Gracefield and Ottawa. After looking over the ground, Mr. Legge will direct what particular work he wants done first and the areas covered. He is not a member of Sir Alexander Binnie's firm, though sent here by him. He is prepared to stay all summer, if necessary, but says no time will be lost. He hopes to get the required information so that Sir Alexander Binnie may make his final report before the winter.

Selkirk, Man.—George H. Bradbury, member for Selkirk, introduced for a second reading to the Dominion Government his bill to prevent the pollution of navigable streams Mr. Bradbury, in opening, pointed out that Canada had spent millions in the material development of the country, in building railways, canals and public works, while little had been done for the health of the people of the Dominion. Providence had been lavish in providing waterways for Canada, but we had neglected to protect these waterways, and they were now proving a menace. Twenty-five years ago the Ottawa River was pure, and to-day one glass of its water contained misery and death to those who had the temerity to drink it. The records of death from typhoid was an awful record for a city like Ottawa. Mr. Bradbury quoted figures prepared by Dr. Charles Hodgetts, of the Conservation Commission, to show the toll of death from typhoid in Ottawa, Winnipeg and other Canadian cities. In Canada the death rate from typhoid was 35.5 per hundred thousand of the population. In Germany it was only 7.6; England, 11.2; Belgium, 16.8; Austria, 19.9; Hungary, 28.3, and Italy, 35.2. In the face of these figures surely it was time that Canada did something, and put an end to the abominable practice of dumping sewage and offal into streams. Typhoid, Mr. Bradbury said, was a preventive disease, and he quoted several sanitary experts on the subject. It was time, in view of the epidemics which had taken place in Ottawa and other Canadian points, for drastic action. During the past ten years there had been no less than 5,796 deaths from typhoid in Ontario alone. He did not believe loss of life could be estimated by money. But, placing each life at $3,000, this meant a total of over $17,000,000. There had been in that time 50,000 cases in Ontario. Each patient lost on an average ninety days, which, at $1.50 a day, meant $6,500,000 in wages. Nursing is placed at five million more, making a total loss in Ontario of $28,000,000. This amount would have been sufficient to give a proper system of sewerage to all the important cities of Canada. On this basis of reckoning the city of Winnipeg had lost five million dollars. Mr. Bradbury explained the situation at Winnipeg. There were two rivers which united at Winnipeg. The Assiniboine flowing from the west carried down the sewage of Brandon and Portage la Prairie. It emptied into the Red River in the heart of the city, and the Red River flowed north with the sewage of Winnipeg, with all its manufacturing plants, and the sewage of Brandon and Portage. Four or five years ago the Government built a dam at St. Andrew's Rapids. Previously the current of the Red was fairly swift, and, while the river was contaminated, it carried the nuisance away. Now the Red consisted of a large basin twelve miles long and one hundred yards wide. The Red, with all this sewage, flowed through Selkirk, and at that point the water was unfit even for cattle to drink. Men could not water their horses in it. Lake Winnipeg had been contaminated for eight or nine miles, and nearly every year there was an outbreak of typhoid among the men who work on the dredges.

Sydney, N.S.—One million four hundred thousand gallons of creosote could have been produced in Western Canada in 1910 if the coal that was converted into coke had been coked in by-product ovens. This is the somewhat startling statement made by the Dominion Commission of Conservation. With the exception of the creosote produced from the by-product ovens at Sydney, N.S., and at Sault Ste. Marie, Ont., no creosote is produced in Canada. This valuable wood preservative is imported from Britain and the United States, but the high cost of the imported article has restricted its use very materially. In view of the steady and even rapid rise in the price of almost all classes of wood products, the importance of creosote is readily seen. For example, there is the problem confronting Canadian railways in obtaining timber from cross-ties. There were 13,683,770 ties purchased in Canada in 1911, an increase of 48.5 per cent. over the figure for 1910. When it is considered that the annual replacement of ties on existing lines amounted to about 10,000,000, it is evident what enormous quantities of tie material are required in order to supply the demand. This demand will not remain stationary, but, on account of the increased mileage of railways being constructed in Canada, will increase each year. Owing to the other demands for lumber and wood products, the price of cross-ties has been steadily increasing. The cost of tie maintenance is now a large item of expense, and the higher prices of the better grades of wood have forced the railway companies to use inferior woods. In 1908 cedar ties constituted 40 per cent. and jack pine (an inferior wood) 10 per cent. of the total used on Canadian railways. In 1911, the proportions were, cedar, 5.3 per cent. and jack pine, 39.9 per cent. In order that the lower grades of wood may be economically used for ties it will be necessary to creosote those species that fail through decay. In order, also, to utilize ties of the softer woods, it is necessary to use tie-plates. When it is remembered that the average life of an untreated tie is seven years, while the life of a treated tie is seventeen years, the importance and value of creosote is readily seen.

Montreal, Que.—Should the plans for the enlarged Montreal waterworks have been submitted to the International Waterways Commission? That is a question which several eminent engineers are asking, and which has resulted in an enquiry into the matter. When the enlarged aqueduct is completed there will be a flow of 6,500 cubic feet per second from the St. Lawrence above the rapids into the waterworks canal, or about one-eighteenth of all the water of the St. Lawrence. This, it is claimed, will have a direct effect in lowering the level of the water above and along the rapids. Therefore, the plans should have been, or should now be, submitted to the Waterways Commission. It has been decided that plans for power plants in the Cedar Rapids and other points must be submitted to the Waterways Commission, and that the enlarged Montreal Waterworks, drawing such a supply of water from above the rapids, should necessarily fall under the same category. In discussing the matter, Mr. T. W. Lesage, superintendent of the Waterworks, stated that: "The plans were never submitted to the Waterways Commission, and there was no reason why they should be. We are drawing the water out of the river near the rapids, and it is going back into the river near Victoria Bridge. I cannot see that the enlarged works will have any effect upon navigation." "Our enlarged waterworks," says Controller Godfrey, who has special charge over the waterworks, "cannot have any effect upon navigation, except as regards the small river steamers. It will not affect the water in the canal. The water flows into our canal above the rapids, and flows right out again lower down, so that it will not affect the level of the river in the harbor. In any event, the plans for the enlarged plant were completed before the present Waterworks Commission was in existence." Against all this, it is claimed that the plans should be submitted to the Commission, even if it were only as a matter for formality, just the same as power projects in relation to the St. Lawrence are submitted as having international importance. City hall officials assert that when the plans for the waterworks were passed some years ago, they were recommended by three expert engineers, who pronounced that they would not interfere with navigation.

PERSONAL.

MR. GEO. B. WILSON, secretary to the mayor of Toronto, has been appointed the head of the street cleaning department, which is to be reorganized.

MR. W. R. SWEANEY, recently acting general manager of the Toronto Hydro-Electric system, has been appointed sales manager of the Toronto Electric Light Company, taking the place of Mr. Parker Kimble, who received an important appointment at Cincinnati.

E. BRYDONE-JACK, Professor of Civil Engineering, University of Manitoba, has opened an office as consulting engineer at 305 Boyd Building, Winnipeg. He will conduct a general consulting practice covering the fields of bridge, structural and concrete work, power development, tests and inspection, etc.

CUMMINS & AGNEW, consulting engineers, Vernon, B.C., have been appointed as city engineers of Vernon, B.C. This consulting firm was recently organized, and consists of a partnership of several established practising engineers. They have several irrigation projects on hand, and are engineers to several towns in the Okanagan Valley. They are undertaking all classes of civil engineering work, both consulting and constructing. Associated in the firm are A. P. Cummins, C.E., B.C.L.S., J. C. Agnew, B.C.L.S., F.R.G.S., D. M. Mathieson, B.Sc., C.E., and J. C. [illegible], M. C. Soc. C.E.

PROF. VAN, graduate of McGill University, Montreal, at present head of the College of Mines of the University of Minnesota, of which university he has been associated with for the last fourteen years, has been appointed director of the department of mines and metallurgy of the Panama-Pacific Exposition, to be held in San Francisco in 1915. He is a native of Holland, and he has had an extensive experience in practical mining work in the United States, Mexico and Canada.

Plans for the Palace of Mines and Metallurgy show that it will be one of the handsomest of the fourteen exhibit palaces now being erected at Harbor View, the exposition site. The extent to which the subject is to be featured at the Panama-Pacific international exposition is indicated by the classification of exhibits in this department, just announced by Capt. Asher Carter Baker, director of exhibits. There will be five groups, subdivided into fifty-eight classes, which will include displays relative to equipment and methods of geological surveys, mining bureaux and other societies for the promotion of mining.

Prof. Van, Graduate of McGill and Director of the Panama-Pacific Mines Metallurgy Exhibit.

The exhibit in its entirety will not only afford exceptional educational opportunities to the public in general, but will be of particular value to mining men in the special fields of their activity.

H. B. PULLAR, Assoc. Am. Soc. C.E., and C. H. ENZENROTH, B.S., announce the opening of their consulting laboratory at 378 Woodward Avenue, Detroit, Mich. Mr. Pullar was formerly assistant manager and chief chemist of the American Asphaltum and Rubber Company, Chicago, and has had long experience in the testing of asphalts and bitumens, and the practical handling of these materials in the construction of roads and pavements, having made and supervised the mixes on approximately 10,000,000 square yards of bituminous roads and pavements of various types.

Mr. Enzenroth is a graduate chemical engineer of the University of Michigan, and has for the past few years been associated with Mr. Pullar. The firm will make a specialty of road and pavement inspection and the testing of bituminous materials. They have a plan for the inspection of pavements which they claim is new, practical and thorough. They intend to give special attention to municipal plant work.

In our issue of April 24th, under the heading of "Personals," a slight inaccuracy occurred when reference was made to the organization of the firm of McPhie, Kelly & Darling, of Hamilton. We find that Mr. McPhie has had an established architectural business there for eighteen years, and Mr. B. F. Kelly, O.A.A., has been associated with him for five years. It was Mr. Darling, not Mr. McPhie, who was connected with the Hamilton Bridge Works Company for fourteen years. We are glad to place this matter correctly before our readers and regret the mistake made. It is the firm's intention to conduct a combined architectural and engineering practice.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson. Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, May 15, 1913

Contents of this issue on page 723

The Canadian Engineer

An Engineering Weekly

FREIGHT TERMINALS AND FREIGHT HANDLING AT TERMINALS.

By J. S. BUSFIELD, B.Sc., A.C.G.I.*

(Continued from last issue, page 680.)

There are a number of different systems of telpher carriers in use to-day which are giving satisfaction, and this seems to be a method capable of development to give very efficient service. It has been proved that distance of travel is a comparatively small factor in the cost of handling by telpher carriers, this fact enables a plant to be installed and operated at comparatively low cost, even where there is quite a long haul.

In a freight terminal it is always desirable that every square foot of space should be covered by the carrier and this is very hard to accomplish with an ordinary telpher, except by a method of "transferage" designed by Mr. W. McL. Harding, of New York, which will be described later.

Telpher carriers are now becoming such a regular feature in connection with freight handling that quite a number of manufacturing concerns are prepared to install them in large houses guaranteeing a saving in the cost of handling that will pay the expense of the installation in from one to two years, depending on the amount and kind of freight handled. It has been asserted that certain manufacturers will agree to install overhead electrical appliances which would transfer freight 1,500 feet at a cost of 5 cents per ton

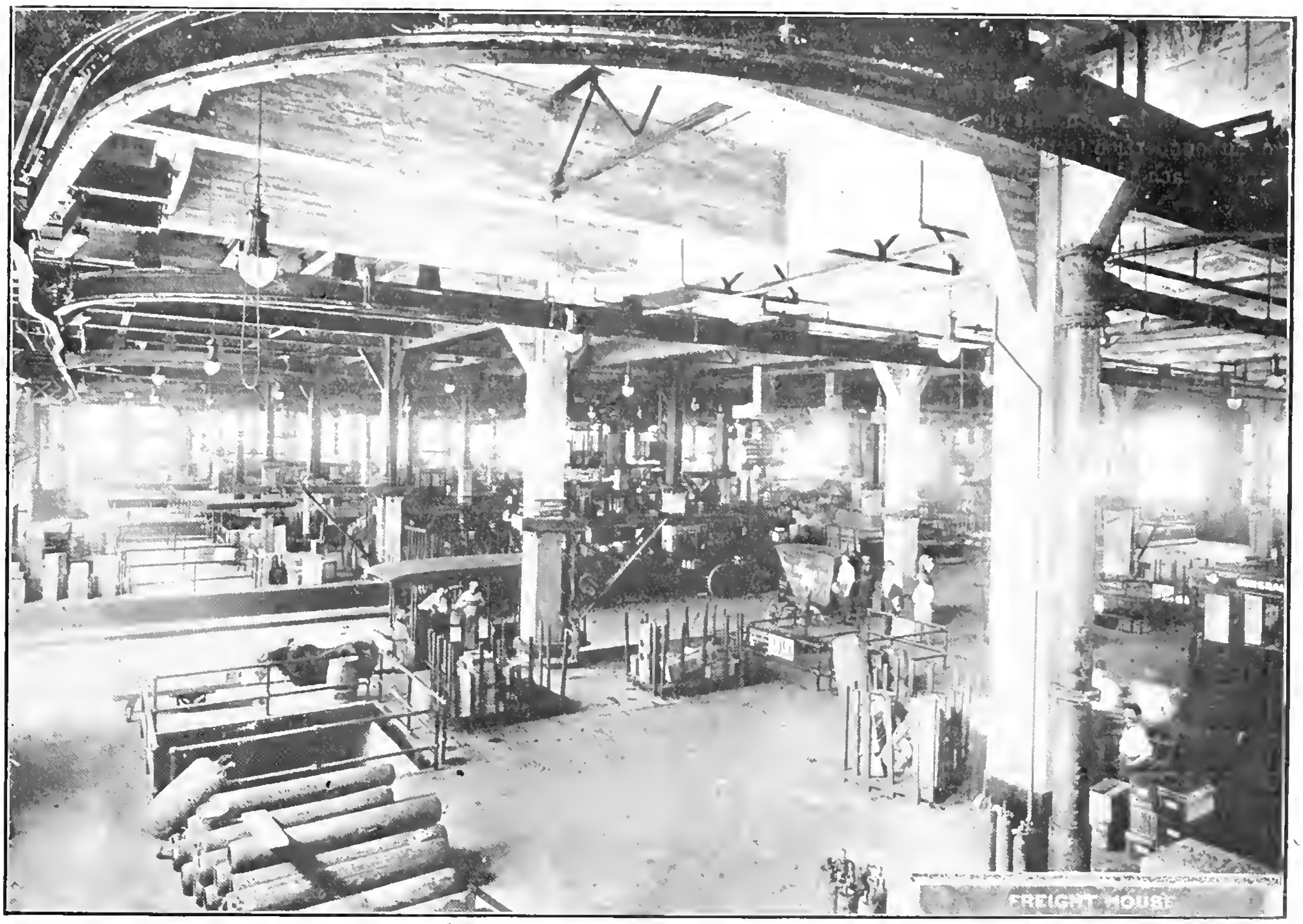


Fig. 11.—General View of M., K. & T. Terminal at St. Louis, Showing Telpher Tracks and Switches; also Tramways Platforms and Hatchways.

* With the Montreal Tunnel and Terminal Company.

for that portion of the work which is now costing more than 25 cents per ton.

A typical arrangement of an overhead telpher carrier system is that in operation at the Bergen, N.J., freight house of the Erie Railroad. A general plan of the houses is given in Fig. 8. It will be seen that there is one inbound platform and two outbound 1,400 feet long with a carrier running down the centre of each platform and connected with cross tracks and switches at each end. A detail view of the carrier truck and running track is shown in Fig. 9. This type is illustrated as being a general sample of a great number of telphers in use. Ten machines operating at one time on the three tracks keeping to the regular routes indicated by the arrows in Fig. 7, would be able to handle 1,000 tons of freight in a day of 20 hours, allowing each machine 6 minutes to make the round trip of 3,000 feet. The average speed of each telpher would be 500 feet per minute, including all stops for picking up and setting down the loads and the maximum travelling speed 1,500 feet per minute.

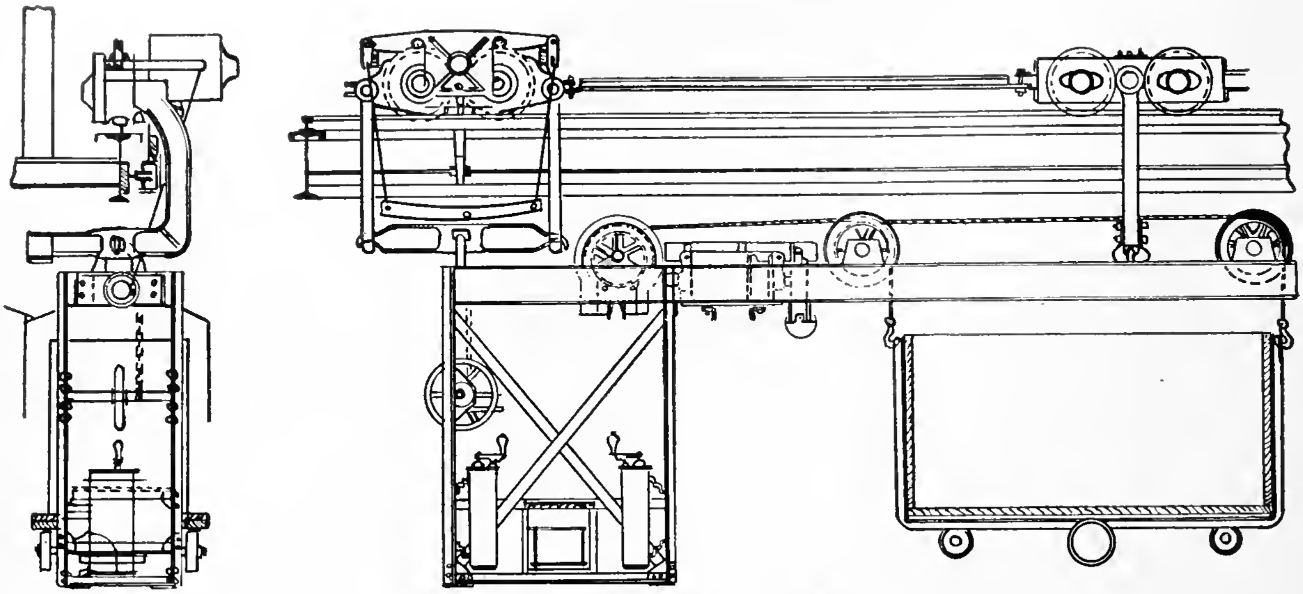


Fig. 9.—Details of Telpher Carrier and Truck.

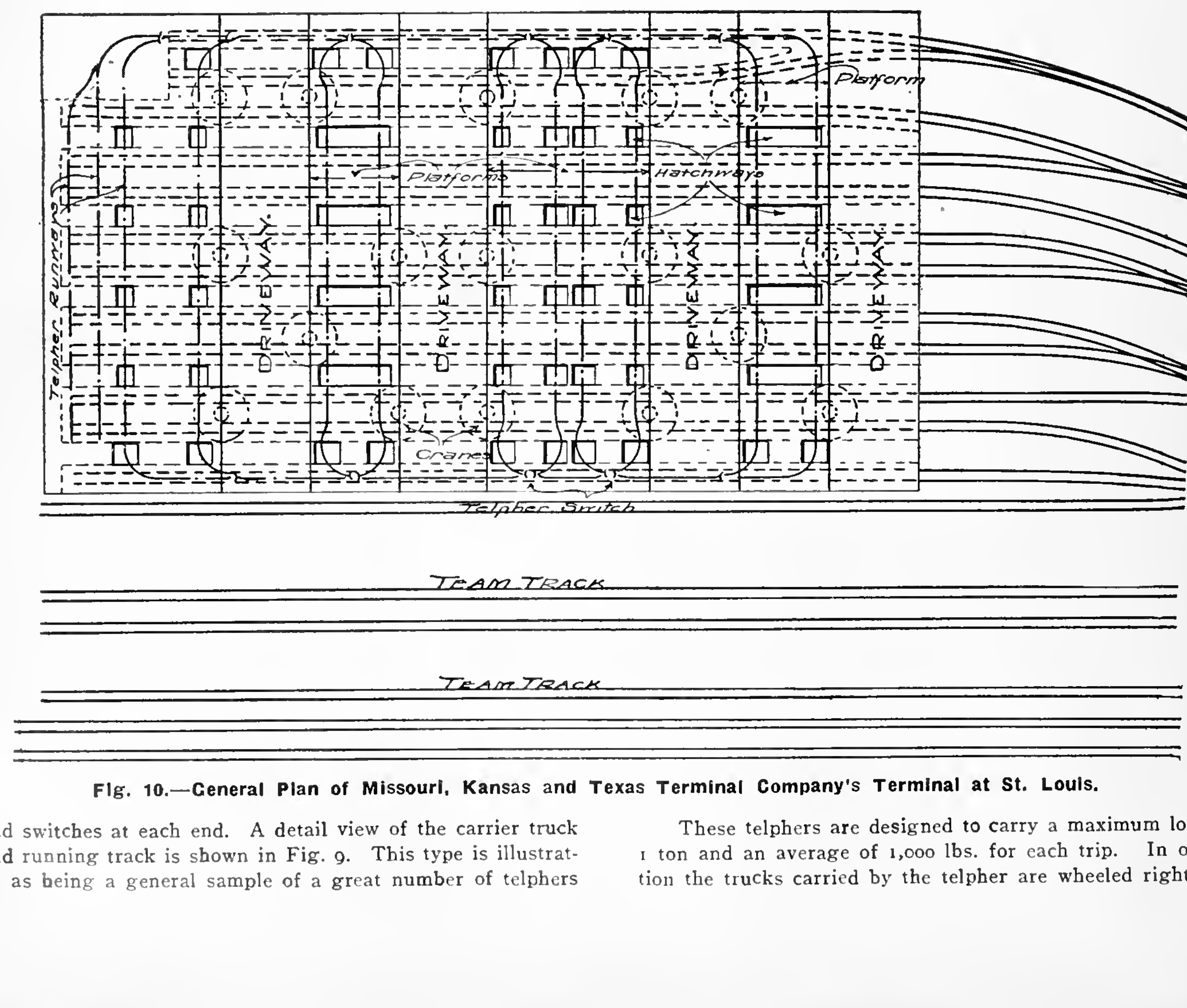


Fig. 10.—General Plan of Missouri, Kansas and Texas Terminal Company's Terminal at St. Louis.

These telphers are designed to carry a maximum load of 1 ton and an average of 1,000 lbs. for each trip. In operation the trucks carried by the telpher are wheeled right into

the freight cars, where they are loaded up with merchandise and then wheeled out to the centre of the platform. The telpher carrier comes along overhead, picks up the load and carries it to the outbound cars, where it is lowered down opposite to the car into which the load is to be deposited. It is then wheeled into the car and unloaded from the truck.

The cost of handling in this manner had been figured at 5 cents per ton, exclusive of the labor cost of trucking the load from the car to its position below the telpher.

The Missouri, Kansas and Texas Terminal Company has erected at St. Louis a double deck freight terminal with the object of reducing the terminal costs, congestion and loss of time in handling L.C.L. freight.

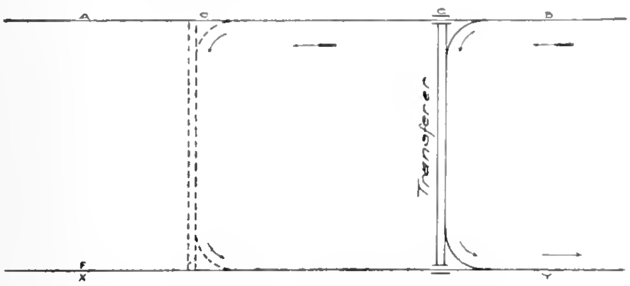


Fig. 12.—Transfer System.

The ground floor of this terminal is occupied by the tracks and cars, and the upper floor is kept entirely for the receipt, delivery and storage of freight. The freight is all transferred from the cars to the upper floor and vice versa by means of an overhead telpherage system, the runways of which are located over the second story. These runways run across the house at right angles to the tracks and in the same direction as the teamways and platforms. At each side of the house is a track connecting all the cross tracks so as to make complete circuits for the telphers. The switches at these end tracks are automatically operated by electricity. A general plan of the building arrangement is shown in Fig. 10, and a view of the team floor, telpher tracks and hatchways in Fig. 11.

The building itself is a structural steel building with brick walls and reinforced concrete floors. In plan its dimensions are 403 ft. by 232½ ft., and accompanying the freight house proper are team, switching and storage tracks and an automobile shed, the whole occupying two and a half city blocks. The shed and mechanical handling plant is designed to handle 100 tons per hour and 75 per cent. of the freight handled is outbound; the capacity of the shed is at present 77 cars, but provision has been made for future expansion. On the ground floor of the building twelve tracks enter from the open north end by ladder tracks with four branches. Each track has a maximum capacity of nine cars. The tracks are spaced in pairs opposite island platforms between the columns supporting the building. With this arrangement trucking through the cars is eliminated and a fixed uniform column spacing is obtained. The platforms are made wide enough to allow two trucks to pass each other.

Immediately east of the building are four team tracks with a capacity of 60 cars, 20 of which are served by a 12-ton gantry crane.

In the upper floor of the building there are four driveways 38 feet wide extending across the width of the building. Alongside the driveways are four platforms, two 82 feet wide and 230 feet long which provide storage space for inbound freight and two narrow platforms 42 feet wide and 217 feet long for receiving outbound freight. All the package freight is loaded up into small platforms or trucks on wheels, which in turn are picked up bodily by the telpher.

The telpher runways are located longitudinally above the wagon platforms, i.e., in a direction at right angles to the tracks on the lower floor. Two runways are provided for each of the 42-foot platforms and for one of the 82-foot platforms, the other 82-foot platform is supplied with four runways. The wheeled platforms and all the loads are transferred from the cars to the teams and vice versa, through a number of hatchways in the floor to the upper level. These hatchways are placed over the low level platforms and below the telpher runways, and so spaced that there is one hatchway for every two cars. Practically no trucking is done on the lower level because all the transferring of freight is handled by the telphers which pick up the load at one hatchway and take it to any other hatchway over the car to which the load is to be taken, here the load is lowered to the cars. At present there are 18 telphers, 16 of which are of 2-ton capacity and the remaining 2 are of 6 tons capacity.

There are 100 wheeled platforms or trucks each 4 feet wide and 6½ feet long, supported on two 10-inch side wheels. Small castor wheels at each end. An arrangement of ratchet lever is fitted to enable one man to move a full loaded truck even up an incline. The telpher machine can hoist these trucks at a speed of 60 feet per minute and travel with them at 500 feet per minute.

In addition to the telpher system there are 17 jib cranes attached to the building columns for loading and unloading the freight from and to the wagons. Fourteen of these are of 1 ton and three of 5 tons capacity.

Transferage.—These two systems of telpherage described have the disadvantage that the carriers must travel over fixed routes and therefore cannot cover areas. A system has been devised by Mr. McL. Harding which will overcome this difficulty by enabling the telphers to cover areas instead of lines. He gives this system the name of "Transferage System."

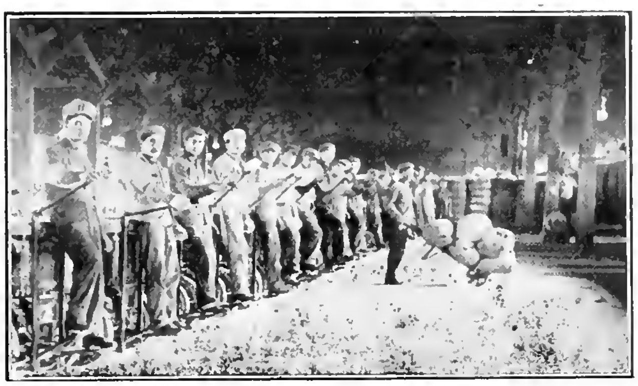


Fig. 13.—Electric Trucks Ready for Use in Freight Sheds.

A diagrammatic sketch illustrating this system is shown in Fig. 12. It is in effect a combination of overhead travelling cranes and travelling trolley or telpher hoists. The following paragraph is taken from Mr. Harding's brief description:

In Fig. 12 let the line A B correspond to the telpher track. A transfer or electric carrier can run in either direction. The transfer travelling in the direction of the arrow at the points C can pass upon the moving switch S and then upon the transferer, which is movable similar to a travelling crane. The transferer is not supposed to move with the telpher and load but can do so if necessary. The load can, therefore, be deposited anywhere in the space between the two lines A B and X Y. The dotted cross lines show the transferer after it has been moved to the left. There may be

two transferers mutually connected upon the same tracks and sets of switches upon each side thus working from cross-overs.

This system seems to be capable of being adapted to suit the varying requirements of a freight terminal. The telphers can be driven at a speed of 500 to 1,000 feet per minute and the transferers, only having short distances to travel, could move at about 100 feet per minute. Trailers might also be used with the telphers and with this system the cost of hoisting, travelling and lowering should not be very high, even for long travel distances.

Motor Trucks.—In the last few years a number of electric storage battery trucks have been put on the market by different concerns and are being quite largely installed in freight terminals. Among the first trucks of this type to be put into use were those of the New York Central at the Grand Central station and the Pennsylvania New York terminal, which were used solely for the handling of baggage. Since then, however, they have been modified and varied into different forms suitable for handling package freight. This type of truck is illustrated in Figs. 13 and 14. Fig. 13 shows trucks ready for use in a freight station, and Fig. 14 shows one loaded.

These trucks have the great advantage of their flexibility, hence their ability to pick up a load at any point in the freight shed and then take it right into the car where the load is to be stowed. This feature, together with their carrying capacity, has in many terminals where they have been installed, enabled the freight handling force to be reduced as much as 50 per cent., with consequent reductions in the terminal costs of handling the freight. The Erie Railroad has at its Jersey City transfer some 20 trucks handling 45 cars of transfer freight and 75 to 85 cars of outbound freight daily, and after an exhaustive test covering the greater part of a year it was found that they were able to reduce the cost per ton from 39 cents to 29 cents, including the cost of running repairs to the trucks.

The following table gives details of the daily average service of motor trucks on a large New York pier:—

Mileage	13.6
Tons handled	225.0
Tons per hour	20.3
Loads handled	230.0
Length of haul	1,585 ft.
Pieces per load	29.8
Weight per piece	88.5 lb.
Time per round trip	2.89 min.
Time to load	58.00 sec.
Time to unload	60.3 sec.
Men in gang	8

A very complete series of tests were made at Providence, R.I., in connection with the performance of these motor trucks, and the accompanying table gives the figures obtained. In the first row the figures refer to the results obtained at the Providence transfer platform, the second is the outbound freight house, third is the inbound freight house, and the fourth is the Providence line pier, Fox Point.

A few general dimensions of the trucks generally in use will not be out of place. Their over-all lengths are usually between 9½ and 10½ feet, with a corresponding length of platform of 6½ to 8 feet. The widths of standard trucks

Fig. 14.—Electric Truck Hauling a Heavy Load of Freight.

varies from 3 to 3½ feet, while the height of the platform above the ground is about 20 inches. The wheel base is made 52 inches and the gauge varies around 3 feet as an average. They are made with varying capacities but the standard trucks as manufactured now do not exceed 3 tons in capacity with the weight of the truck about 1 ton. They are usually designed to give a maximum speed of 10 m. per hour, with a range of intermediate speeds.

The use of these trucks is naturally only in its infancy, but where they have been installed they certainly have shown marked decreases in the cost of handling freight.

Conclusions.—In summing up and studying the relative merits of the different systems of handling freight by mechanical means, each system will be found to have its disadvantages; for instance, in the case of an overhead telpherage system, the telphers are practically confined to fixed lines of travel, and the loads which they have to handle have to be

	* Hours in Service	* Distance (Feet)	* Weight (Pounds)	Average Tons p Hour	* No. of Loads	Average Length of Haul (Feet)	Average Number of Pieces per Load	Average Weight per Piece (Lbs)	Average Weight per Load (Lbs)	* Total Number of Pieces	Maximum Load (Lbs)	Average Mins Running per Load	Average Time to Load (Mins)	* Total Hours Loading & Unloading	* Total Hours Running	No of Men in Gang	* Wages of Men	Cost of Labor p. Ton Including Checking Clerk	* Wages, Not Including Checking Clerk	Cost of Labor per Ton Not Including Checking Clerk
1	87 4	175930	501956	2 87	402	438	13 5	92 4	1248	5419	4500	4 40	5 90	60.53	29 50	3&4	55.70	22.191	35 77	14 251
2	105 17	67315	630709	3 00	527	128	15 4	77 7	1197	8086	5100	2 70	4 57	80 88	24 30	3	58 42	18 523	34 78	11 024
3	120 53	143840	742923	3 13	561	256	15.4	86 0	1324	8629	9000	2 75	6.90	94 78	25.77	3&4	76.13	20 495	49 22	13 250
4	55 19		717839	6 53	467	177	10 2	150 5	6080	4767		7 10					34 03		34 03	9.482

* Total for 13 days in *1 & *4.
" " 12 " " *2 & *3.

transferred into the cars by hand. This disadvantage can be reduced though by the use of a number of wheeled platforms such as are in use at the St. Louis terminal previously described.

Again, taking the use of electric storage battery trucks, they are able to overcome this difficulty of the telphers, but on the other hand, they have the disadvantage of requiring a great deal of platform space on which to make their necessary movements, which space might be advantageously used for storage purposes in the case of a telpher system. Another disadvantage of motor trucks is that in order to handle a large business it would require more motor trucks than telphers on account of the fact that the truck has to wait for the unloading and loading up, whereas the telpher carrier picks up or deposits its load and continues its journey to take another load, and it is continually doing efficient work. For this reason it does not seem as though the motor truck could be so efficient as a telpher system, as it can hardly be conducive to economy to have an expensive piece of machinery lying idle for some length of time. Possibly this difficulty can be overcome by the use of trailers, or with small platforms or removable bodies to the trucks. This is a development which no doubt will soon be put into practice.

In designing a freight terminal engineers should take great care to consider the question of mechanical handling of freight. Even if there is no intention of making such an installation immediately, provision should be made for the future handling of a growing business by mechanical means, by looking into the subject and ascertaining what method is most suitable to the particular conditions and requirements of the terminal in question and, if necessary, making such alterations to their design that will enable the necessary machinery to be installed when the business at the terminal warrants the additional expense.

The following table gives a few figures which have been gathered from various sources and which are of use in figuring on the design of a freight terminal:—

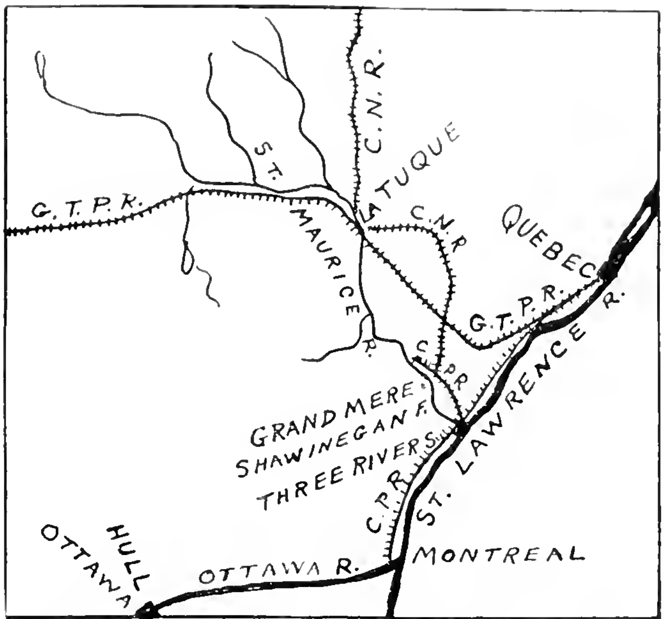
Average load on hand truck	225 lbs.
Average trucker's speed (per minute)	125 ft.
Average tonnage in a car (varying in different localities)	10 to 20
Average cubic feet in a car	1,200
Average width of drays	6 ft. 3 in.
Maximum width of drays	8 ft. 6 in.
Minimum width of drays	5 ft. 0 in.
Average length of drays and teams	20 ft. 0 in.
Maximum length of drays and teams	34 ft. 0 in.
Minimum length of drays and teams	13 ft. 0 in.
Average speed of telphers (per minute)	600 ft.
Maximum speed of telphers (per minute)	1,500 ft.
Average speed of motor trucks (per hour)	6 miles
Maximum speed of motor trucks (per hour)	10 miles

In conclusion the writer wishes to express his indebtedness to Mr. John A. Droege, superintendent of the New York, New Haven and Hartford Railroad for his kind permission to use his book "Freight Terminals and Trains" from which many of the diagrams and data contained in this article were obtained, and to the Sprague Electric Company, of New York, for the illustration of the St. Louis terminal of the Missouri, Kansas and Texas Company.

A concrete bowstring roof truss is a feature of the recently constructed Belleville Theatre in Paris, France. The truss has a clear span of 69 ft. and an overall height of about 15 ft. The top chord approximates a parabola and is connected with the bottom member by six vertical suspenders, spaced about 10 in. on centres.

ST. MAURICE VALLEY FOREST PROTECTIVE ASSOCIATION.

One of the most significant gatherings held in Montreal was the annual meeting of the St. Maurice Forest Protective Association held recently at the Place Viger Hotel. This organization, which is just one year old, marks the beginning of a new era in forest protection. Hitherto the matter of protecting the forests has been one between the individual limit holder and the government. In this field the advantages of co-operation are very great, but until the formation of the St. Maurice Association every lumberman battled with the fires on his own limits as best he could. A year ago the limit holders in this valley, seeing the waste and inefficiency of individual effort, got together and formed an association. They appointed a general manager who took charge of all the fire rangers and directed them as one army, posting every man where he could be of the greatest advantage. The association, which controls an area one hundred and sixty miles



Map Showing Location of St. Maurice Valley, Quebec.

long with an average width of one hundred miles, embracing in all seven million acres, taxed itself one-quarter of a cent per acre, and to the $17,500 thus raised the government of Quebec added $3,000. With this money there were opened or re-opened 525 miles of pack trails, there were purchased canoes, axes, shovels, tents, and gasoline motors for railway patrol, and a beginning made in erecting telephone lines and in connecting these with existing telephone systems. The result was that 97 incipient fires were promptly extinguished and the association came through the year with practically no loss. This year it is proposed to extend the trails, to connect up the telephone lines and to erect lookout stations from which watchmen may send out warnings to headquarters so that a sufficient force of men may be sent promptly to put out the fire. The officers for the first year were: President, Mr. Alexander MacLaurin, of Montreal; vice-president, Mr. W. R. Brown, of Berlin, N.H., and La Tuque, Que.; manager, Mr. H. Sorgius, of Three Rivers. Owing to the illness of Mr. MacLaurin which has necessitated a trip to the south, and the occupation of Mr. Brown with other features, these gentlemen (though both are enthusiastic over the work) retired and the new officers elected were: President, Joseph Dalton, Three Rivers; vice-president, S. L. de

Carteret, La Tuque; manager and secretary, H. Sorgius, Three Rivers.

One of the successful features of the gathering was the banquet at the Place Viger Hotel when about twenty-five gentlemen, members of the association or interested in the work, discussed an excellent menu and afterwards listened to a few pithy speeches.

UTILIZING SAWDUST.

By C. W. R. Eichoff, M.E.

The inconvenient process of burning this valuable waste, taking into consideration the fact that this sawdust, when moderately dry, has the same heat value as the wood from which it originates, has led to the design and construction of many different styles of furnace, which in some cases have brought a betterment and in others failure. Furnaces of the "Dutch oven" style are mostly used in this connection, and especially with boilers. But there are other convenient constructions now in existence. In all these furnaces the main effort was directed to a better distribution of the air necessary for a successful combustion of the material.

Abroad, where conservation of the natural resources has been practised to a greater extent than on this continent, experiments have been made to form this dust into briquettes. At present a number of briquetting plants are in successful operation across the Atlantic, and of later years lumbermen and other mill-owners on this side of the Atlantic have become interested in the briquetting of such sawdust. But the American has not looked favorably on this utilization. The large lumber concerns considered it more profitable not to bother with such a process, claiming that these briquettes can be used only to a small extent and could not compete with other fuels in which this continent is so rich. More interest in the matter was shown by the smaller concerns, where the loss of such valuable wood wastes demands serious consideration. Many owners took up the proposal, but dropped it when they learned the cost of such sawdust briquetting plants. Considering that a product has to be manufactured which requires for its fabrication either a suitable binder or great pressure not using a binder, it is essential that every part of such a plant be designed and constructed with the utmost care and skill in all its details.

Suitable binders are water-gas, pitch, tar, rosin, flour, water-glass and others of the same nature as used in the briquetting of coal. As these binders materially increase the cost of manufacture, their use was found prohibitive, and machines are now used that deliver the goods without the application of a binding material.

The sawdust in this process has to be perfectly dry before being put into the press. From the press the briquettes are transported automatically into a cooling room, and when cool they are hard and ready for transportation. Such briquettes are an excellent fuel for residence use in fireplaces and stoves, do not corrode, and leave very little ashes and soot. The cleanliness, rapid ignition, intense heat and odorless combustion make them a fuel preferable to the best wood. They are also the most convenient fuel for power house use in saw-mills and in logging locomotives, replacing coal or sawdust, which latter would take considerable space. They are also very convenient as a kindling material. The briquettes are of oval form, to facilitate ventilation when piled up.

Presses are built with a capacity of 24 briquettes a minute, giving 14,400 briquettes in ten hours, each briquette weighing about half a pound, which would be equivalent to a daily output of 3.6 tons. The power required for the driers and this press amounts to about sixteen horse-power. Another press has a capacity of nine tons a day, requiring 45 horse-power for the machine.

Use for Dry Distillation.—A very attractive process is the charring of sawdust and subjecting it to a process of dry distillation. The remaining charred material (charcoal) is then briquetted and yields a briquette of very high heat value, equivalent to the best anthracite coal. The process is practically the same as that used in the distillation of wood. The resulting by-products are an illuminating gas, which can be used to light up the mill, wood vinegar or pyroligneous acid, wood spirits or methyl alcohol and wood tar. The wood tar can be subjected to further treatment and yields creosote, benzol, naphthalin, paraffin, etc.

Sawdust has been used for the operation of gas producers for power purposes, in which cases it can be handled either in the loose form or in the form of briquettes.

Related to the briquetting of sawdust is the manufacture of artificial wood. This material is of great tenacity and strength, does not decay and is less susceptible to the action of the atmosphere than is natural wood. All this artificial wood can be sawed, planed and cut, but not split. The manufacture of it has become quite an industry abroad. Decorations for walls, ceilings and furniture are manufactured from mixtures the essential part of which is sawdust. These ornaments rival carved work and are a great deal cheaper, replacing those made of zinc, papiermache and artificial stone or cement.

Sawdust is the essential part of a stone-like material used for building purposes and also for paving blocks. These paving blocks are said to outlast the regular creosoted wood blocks.

Sawdust is pulverized and used instead of sand. In this state it can be colored, perfumed and used for many purposes, such as for sachet bags and the like.

Miscellaneous Uses.—The writer remembers the time when this fine sawdust was used in offices instead of sand and blotters. Its polishing qualities in the pulverized state for gold and silverware are well known. Further, from fine dust of colored wood, such as mahogany, etc., stains can be made to be used in imitating other woods. With linseed oils one can make a filler. The material for this filler is best obtained from the kind of wood on which it is to be used.

Sawdust and shavings are used for packing glassware, porcelain and other ceramic articles. In this state it must be dry, so as not to have a detrimental effect, especially on ceramic goods.

The use of sawdust for cleaning floors is too well known to need mention; not so generally known is its property of preserving eggs.

Any person handling oily and painty tinware should know that it is an excellent means for cleaning fresh paint from such tinware, rendering the vessels perfectly dry and clean.

Sawdust is used in the manufacture of insulating material for steam boilers and steam piping, and as insulating filler in fireless cookers, ice boxes, walls, etc.

It can be laid in cement floors instead of sand, rendering these floors warmer and more porous. It is used for roofing material instead of sand, making roofing paper lighter for transportation and so reducing cost.

Charred sawdust is an excellent means for filtration of liquids and has disinfecting qualities, making it more suitable for this purpose than ordinary charcoal. Added to brick it makes a more porous brick. Mixed with clay it can be used for the manufacture of filtering articles; this has proved to be an attractive process.

Sawdust is used to absorb moisture in building walls that are exposed to water. In the manufacture of cheap wallpaper and artificial flowers it is used in the form of a fine dust. Other uses are for cementation in steel mills, for cleaning purposes in the production of gas, in the manufacture of calcium carbide and carbonundum, and, in foundries, for pickling.

Everybody knows of its application in the manufacture of powder and explosives. Further uses are for floors in gymnasiums and riding schools, for the manufacture of paper, for slippery streets in winter, and for bedding in stables. Sawdust improves soil mechanically, and, when saturated with stable manure, it also works chemically on the soil and so improves it. Sawdust is also used in sawdust mortar (for moist places) and in horticulture to protect hotbeds, etc. With proper manipulation a good wood soil, so valuable in gardening, can be obtained. In the manufacture of soap for washing and cleaning purposes sawdust is also employed.

Very promising is the manufacture of sugar and alcohol out of waste woods; but these processes are not yet far enough advanced to be of commercial value and to justify large expenditures at the same time. Finally, sawdust is the only material now used for a cheap production of oxalic acid.

DISADVANTAGES OF CHEMICALLY PURE WATER AS A BEVERAGE.

Word comes of investigations carried on by a number of French naval surgeons into the use of chemically pure water as a drink, which may be of interest to some of our readers.

To make water chemically pure it has to be distilled, and the continued use of distilled water as a beverage reduces the strength of the physical organism, because, while it is free from all germs, it contains nothing but oxygen and hydrogen. The mineral salts are left behind during the process of distillation, and the mineral salts are really indispensable.

"As long as life persists in the body," these surgeons declare, "the elimination of mineral salts goes on, and this means the rapid demineralization of the organism."

Demineralization, it is explained, leaves one's system in such a state that the natural tendency is to become tubercular. It was found that there were numerous cases of tuberculosis among the young sailors of the French navy, and this was, after long investigation by the surgeons of the navy, attributed to the demineralization of the water.

The distilled water was used in the belief that it was best for the sailors, and the naval authorities were anxious to make every condition as healthy as possible. Just now the surgeons are studying the best means of treating the distilled water used aboard the ships with mineral matter. Of course, pure water is wanted, but as conditions are now it is held that ordinary drinking water would be even better than the chemically pure, if the latter was responsible for the increase of tuberculosis in the navy.

Few people continually drink chemically pure water, and for this reason the dangers could not well be learned until this discovery was made. There are a number of ways in which the germs in water may be eliminated and at the same time the mineral salts left in the fluid. Distilled water is scarcely palatable at the best, as it is these very necessary mineral salts that make it really palatable.

An effort is being made to provide further proof of the dangers of chemically pure water as maintained by the surgeons of the French navy by means of experiments on animals.

USES AND ABUSES OF WATER FILTRATION.

At the meeting of the New England Waterworks Association, Mr. G. H. Pratt, chemist of the Rhode Island State Board of Health, read an article on the above subject, an abstract of which we give below.

In connection with the uses of filtration of water, the author would first mention a few of the conditions which call for such treatment. For many years a town or city may have been using some water of comparatively good appearance as a supply, when suddenly there appears an unusual amount of typhoid fever among the people. Investigation demonstrates that it is the water supply which is common to these cases, and bacteriological tests prove that the water of the stream is polluted. Further investigation shows that there have been some cases of typhoid in a small village upstream, which has no sewage purification, and the excreta from these cases has found its way into the water supply of the down-stream neighbor. This experience—such a common one in the case of cities and towns taking their supplies from streams which have an increasing population on the watershed—leads to a full appreciation of the need of purification, and the resulting improvement in the supply with attendant betterment of the health of the community serve as evidence of one use to which filtration is put.

Another city may be enjoying an exceptionally good health record, especially as to typhoid fever, but the presence of a large amount of organic matter, giving the water a high color and a vegetable taste, causes criticism of the supply, and, regardless of analyses as to its sanitary purity, a large number of citizens persist in the contention that the supply is not what an up-to date city should be furnishing, until finally it is decided to filter the water by mechanical filtration in order to get a water of better appearance. The criticism above referred to immediately ceases, and the people receive a practically colorless water with comparatively no taste in place of the old familiar "organic brew." Thus æsthetic reasons may in many cases be sufficient cause for filtration, and the resulting output certainly justifies its use in these cases.

Similar to the above instance, the presence of different algæ may be the cause of disagreeable odors and tastes which demand filtration by methods which, in such cases, usually require aeration in conjunction with either double slow sand filtration or mechanical filters.

Some cities or towns and numerous small private supplies have been troubled, in cases where the supply is from driven wells, by the presence of iron in the water. This iron often exists in the lower state of oxidation or ferrous condition and upon contact with the air separates from the water as a "brick dust" sediment. Such supplies as this can be purified by methods involving aeration and oxidation of the iron before filtration or in the case of smaller supplies this has been successfully done by the use of a patented double filter which utilizes sand and animal charcoal.

Many industrial processes, especially bleaching and dyeing, require water of good color, low in iron, and free from turbidity. This requirement has resulted in the installation of a large number of filter plants, and the use of filtration for these purposes has been invaluable to numerous mills of this and other countries.

A great many times filtration is resorted to largely, if not entirely, to remove turbidity from the water. This is true of many western waters.

Having thus brought out different conditions which call for the use of filtration, the author will now cite certain concrete instances of illustrations which have been made for the different reasons above mentioned, and will present results

which will show the efficiency of such plants when properly operated in improving the objectionable features which they were primarily installed to remove.

As instances of purification of supplies which have at times, prior to the use of filtration, been the cause of typhoid fever,—or, in other words, as instances to illustrate filtration for removal of bacterial pollution—we may cite Lawrence, Mass., and Providence, R.I. The Merrimac River receives sewage pollution at Lowell and at many other points above Lawrence, and its average bacteriological condition during 1910, to cite one typical year, as received on to the filters, was a total count of 9,100 bacteria per c.c., and the colon bacillus, which is taken as evidence of the presence of sewage contamination, was present in all the samples examined in 1 c.c. tests. The output from the plant (old filter) showed only 57 bacteria per c.c. and the test for B. coli communis was positive in only 8.3 per cent. of the samples examined in 1 c.c. tests. This shows a removal of 99.4 per cent. of the bacteria and a very marked improvement of the conditions as to the presence of B. coli communis.

The water supply of Providence is obtained from the Pawtuxet River, and prior to the year 1906 was used without filtration. During these years there were at least two typhoid fever epidemics which were traceable directly to contamination of the drinking supply of the city. The first was in 1882 and the second in 1888, the latter epidemic being caused by the fact that the attendants upon a case of typhoid fever had considered the river a means of quick disposal of the fecal matter of the patient.

TABLE I.
PROVIDENCE WATER SUPPLY.
(1902—1905)

Source.	No of Samples.	Average Turbidity.	Average Sediment.	Average Color.	Average Bacteria per c.c.	Remarks
Intake	96	Slight to decided	Considerable .	46	4,000	
Tap in city. .	96	Very slight to slight	Slight	41	730	After reservoir system and distribution
Per cent removal	—	Appreciable ..	Appreciable ..	10.9	81 8	

(1906—1911)

Source.	No. of Samples.	Average Turbidity.	Average Sediment.	Average Color.	Average Bacteria per c.c.	B Coli in 10c.c. tested. Per Cent. of Samples	Remarks.
Intake	144	Slight	Slight to considerable ...	48	2,525	92	
Tap in city...	144	None	None to very sight	28	60	1.7	After filtration, reservoir system and distribution
Per cent removal	—	Complete	Almost complete	41.7	97.5	—	

Agitation for purification immediately followed this last epidemic, but it was a number of years before the type of filter could be settled; but finally, in 1902, the contract was let for slow sand filters, and beginning with 1906 the city was furnished with filtered water. The results were noted at once, not so much from the standpoint of color—for as in the case with this type of filtration only a comparatively small per cent. of color is removed,—but by the freedom of the water from turbidity and sediment and by a reduction in the organic matter which had caused a marked vegetable odor and taste. Besides the visible improvement in the supply, the analytical study of the conditions before and after filtration showed the changes which were effected, and the excellent sanitary condition of the supply.

As an indication of the work which these filters have performed, I would present (Table I.) the following figures, showing the average condition of the river as to appearance, color, and bacteria for four years from 1902 to 1905 inclusive as shown by bi-monthly tests made by the Rhode Island State Board of Health, and for comparison similar figures on samples taken from a tap in the city covering the same period. These figures show that during this period the distribution system and reservoir storage effected some purification as shown by the slight improvement in the appearance, a removal of 10.9 per cent. of color and 81.8 per cent. of bacteria. Tests for B. coli communis were not made by the board at this time.

Similar figures are also presented (Table I.) showing the average condition of the river for six years subsequent to the use of filtration covering the years 1906 through 1911, and similar figures from a tap in the city for comparison. These figures show a marked improvement in the appearance of the water, a 41.7 per cent. of removal of color, as compared with only 10.9 per cent. due to the reservoir system prior to filtration, which would indicate 30.8 per cent. due to the filters themselves, and show a removal of 97.5 per cent. of the total number of bacteria present. B. coli communis was found to be present in 92.0 per cent. of the number of samples tested on the river, and in only 1.7 per cent. of those taken in the city during the filtration period, these tests being on 10 c.c. samples.

In the preceding tables one sample has been omitted in striking the bacterial averages for the tap in the city during the six years of filtration because of the fact that certain conditions which will be brought out later required the use of river water which affected that sample. The figures presented, therefore, are a true measure of the water of the city during filtration, and show the good work which has been accomplished in removing the bacterial pollution from the water.

The water supply in East Providence is taken from the Ten Mile River, which is a polluted stream receiving sewage from Attleboro, Mass. The condition of this river became such that in 1899, upon the recommendation of the State Board of Health, a mechanical filter plant was installed. The results have been highly satisfactory, showing a reduction from 8,160 bacteria per c.c. in the river to 33 per c.c. in the effluent, or a removal of 99.6 per cent., and complete removal of B. coli communis at all times. These analyses were of monthly samples taken the first eleven months of this year. In addition to this efficiency for bacterial removal, the plant at the same time reduced the color from 61 in the case of the raw water to 6 in the filtered water, or a removal of 90.1 per cent.

From the above, it has been plainly shown what can be accomplished by either slow sand filtration or mechanical filtration in removing dangers from bacterial pollution of water supplies, and it would seem to indicate very little choice between the two systems from the standpoint of removals effected, but with the advantage in favor of mechanical filtration from the standpoint of removal of color from water high in organic material. I will not attempt to go into a discussion of the relative merits of these two systems of purification, as that is not the subject of this paper, but I will simply say that each system is efficient under certain conditions, and local conditions should, in all instances, assist in the selection of one or the other method.

As an instance to illustrate the use of filters for removal of color, I would cite the case of the plant at East Warren, R.I., where during 1911 the color in the raw water averaged 74, and was reduced by the mechanical filters to 11, or a removal of 85.1 per cent. This plant is an illustration of a case where slow sand filters, while they would have delivered a sanitary output, in a short time would have experienced

trouble from algæ present, and the output would not have given satisfaction to the consumers because the water would still have been highly colored instead of being practically colorless as is the present condition.

At Newport, R.I., there is a mechanical filter plant which has been installed to serve a double purpose of removing bacterial pollution and also to remove odors due to algæ. This is an up to-date plant in every way, using a system involving aëration, coagulation, and sedimentation, followed by filtration and then disinfection of the supply with hypochlorite of lime. The color of this water is comparatively low, and the resulting output is of good appearance, when the plant is being operated up to its possibilities, and the effluent is largely free from algæ and odor troubles. Likewise, the water is reduced as to bacterial count to a point where it is practically sterile.

Next passing to the question of concrete instances of installations for the removal of iron, I would mention the the plant at Marblehead, Mass., where by the use of aëration and filtration through sand the color of the water is improved from a rusty appearance to a practically colorless water, and the iron is reduced from 4.70 parts per million to .06 parts, or a removal of 98.7 per cent. One installation has come under my personal observation where the particular apparatus above referred to, which employs a double-cylinder filter using sand and animal charcoal, showed a removal of iron 8.00 parts to .10 parts, or 98.75 per cent. removal, with accompanying improvement in the appearance of the water.

In connection with the use of filters in the purification of water for industrial purposes, I would say that I have been touch with a number of installations where mechanical filters have been installed of different types which, when properly operated under proper supervision, turn out a product which gives entire satisfaction and shows purification in every way comparable with the results above given.

In treating the second part of my subject, namely, the abuses of water filtration, I would call attention to a number of ways of abuse which might lead to criticism of the whole idea of filtration, but in citing these cases where such abuses have occurred, for obvious reasons I will refrain from naming the installations in most cases.

In the case of slow sand filtration, one would consider it an abuse to attempt to purify a water high in algæ content which would result in clogging of the beds and a general upsetting of operating conditions at the plant. Of course, double slow sand filtration, especially if in connection with aëration, would qualify this previous statement, as aëration and a pre-filter would put the water in condition where it could be handled by the secondary filters, but where aëration followed by coagulation and sedimentation and filtration by mechanical filters would obviate all of the trouble due to clogging of the beds, it would seem as if it was abusing the at times satisfactory method of slow sand filtration to attempt to handle such a water by simple slow sand filtration.

It would also seem an abuse of this method to use it in connection with filtration of highly colored water, which would subject the method to criticism on account of the unsatisfactory appearance of the output.

Another abuse of this method in connection with operation of the filters is too quick changing of rates of operation, which tends to disturb the bacterial action going on at the surface with attendant poor results from an analytical standpoint. Also attempting to overcrowd the filters by running at too high rates is a practice which is sometimes met with, which results in diminution of the efficiency of the plants.

A slow sand filtration plant which would handle a given water satisfactorily might, as was the case in Providence, be installed without covering the beds. Such an installation as this in this section of the country is certainly an abuse of the method, for the result invariably would be what was found in Providence, that as soon as a hard winter struck the plant the beds would become covered with ice and it would be impossible to get at the surface to clean without removal of the cakes of ice. This condition occurred in Providence for a short time during February, 1907, finally necessitating opening the river gate, and the use of raw water for about two weeks or so before the weather moderated and before the ice could be removed. This experience resulted in steps immediately being taken to cover the beds, and this experience should serve as a lesson against such open installations in this section of the country.

In connection with slow sand plants, it is necessary to have competent help administering the plant, and one of the easiest ways to abuse a plant is to put it into the hands of inexperienced operators.

The above remark about labor in connection with plants is especially true in the case of mechanical filters where the supervision must be particularly close and where tests for color and alkalinity must be made to regulate the doses of chemicals used.

One of these plants which has come under my observation has operated for a number of years satisfactorily, turning out a water which had given entire satisfaction in connection with work in a bleachery. When I was consulted with regard to difficulties which were occurring, I found that the only trouble was that the parties in charge did not have an understanding of the question of alkalinity control of the plant, and the residual alkalinity of the effluent had dropped to a point where the water was passing the plant at times in an acid condition, or at best with an extremely low alkalinity, resulting in after-coagulation in the vats and throughout the system. This condition had been caused by the fact that a certain mill above them had been discharging a larger amount of acid wastes in the river than at the time their formula for operating was figured for them. Not knowing how to vary the dose from time to time, they had stuck to the old formula with the resulting poor work until corrective measures were taken. The addition of alkalinity to the water put the plant back into its former good condition.

At another installation concerning which I had been consulted, I found another condition which was causing trouble. The responsible man in charge of the plant for some reason or other was assigned to night duty, and he was attempting to make his control tests for color and alkalinity at night by artificial light. This, of course, gave far from accurate results. Another trouble at this plant was that the one man was expected to operate the flow of chemicals from the tanks which were located in the pump house and at the same time attend to washing the filters in a filter house which was located about one-eighth of a mile away. This spreading out of the plant made it impossible for the lone operator to properly attend to the dosing, and the result was that the flow of chemicals varied from time to time, with resulting poor output from the plant. Here, too, I found trouble in connection with the dosing, for the formula they were using to operate by had evidently been recommended without a knowledge of the water to be handled, and they too were operating with a too low residual alkalinity.

At another plant this same trouble as to a low residual alkalinity was found to exist, and the output contained undecomposed sulphate of alumina. Investigation showed that this operator was using an indicator solution many times too

strong, and the alkalinity tests which he was obtaining were absolutely inaccurate. They also were not showing intelligence with regard to the necessity of increasing the doses of chemicals to meet varying conditions in the raw water. Corrective measures, recommended by the State Board of Health, and instruction of the operator, has resulted in this plant turning out one of the best outputs in our state at the present time.

At still another plant the biggest difficulty discovered when troubles arose seemed to be with the application of the chemicals, which in this plant required an extremely close control on account of an influence on the color of the filtered water as the residual alkalinity became too high. The engineer who was employed when this plant started was a man who had been for years pumping water out of the reservoir under the old system, and he could not be made to realize that careful supervision was necessary, and grossly neglected controlling the flow of the chemicals. These operating troubles immediately ceased when a new, competent engineer was put in charge of the plant.

The effect of an abnormal amount of organic matter or algæ in comparison with the color of the water sometimes has resulted in an under dosing with coagulant, as this additional amount of organic matter has seemed to prevent proper coagulation with resulting incomplete removal of the constituents which it was intended to remove, and the effluent has contained alumina and abnormal amounts of color and algæ. Proper dosing in view of the above-mentioned conditions has resulted in excellent work from this plant.

Another abuse is oftentimes attempting to operate a plant, with every possibility for good results, by methods which some men of limited experience may have used at some other plant, meeting entirely different conditions. Such cases have occurred under my observation, but have been capable of adjustment when instructions have been given which had in mind the type of plant and the raw water to be handled.

In connection with the operation of plants of the mechanical type, it is essential that the night man should be one who can be depended upon to stay awake, as a nap for an hour or two may result in throwing the whole operation of the plant out of adjustment for several hours. I have had my experience with this trouble.

Having thus brought out the conditions which call for filtration of water supplies and having shown the good results obtained with certain installations, I have also attempted to point out a number of ways in which filtration plants are at times abused. One or more instances of abuse are sometimes the only cases of filter plants coming to the attention of some people who immediately condemn the possibilities of the whole proposition of water purification on this meagre knowledge.

I would take this opportunity to warn you waterworks men against such conclusions from knowledge of some plant or plants which may not be doing all that has been claimed for them. I would also particularly caution that you do not take the cases of abuse which I have mentioned as indicative of any lack of confidence on my part in the ability of plants to purify water satisfactorily when the following essential points have been observed: First, have the choice of the system and the general outline and construction of the plant in the hands of competent consulting engineers who are experts in these matters; next, having obtained the plant properly constructed and designed to handle the water to be filtered, obtain the best possible men to oversee and run the plant after instruction from competent specialists, and if trouble occurs, call in advice to straighten out the difficulty instead of experimenting blindly; and last, throughout the whole operation of the plant bear in mind that you are handling an efficient machine capable of results, and not an automatic affair which can be left to its own resources.

HOT GALVANIZING.

A new hot galvanizing process has recently been patented by Professor Charles F. Burgess differing from other previous processes in that it covers the use of an alloy of zinc and iron for coating iron or steel. The alloy is composed of about 92 per cent. of zinc and 8 per cent. of iron, and is prepared in a powdered or granulated form. The alloy is applied to the iron and steel in a similar manner to the well-known process of sherardizing.

Arthur D. Little, Inc., of Boston, who touch upon this matter in their report as official chemists to the American Institute of Metals, say that it is claimed by the inventor that the finished coat is dense and silver white in color and electro-positive to iron, but less so than pure zinc, with the result that it does not corrode as rapidly as zinc, and yet at the same time protects the iron or steel equally well.

CONDENSER TUBES.

A number of interesting papers have been presented before the British Institute of Metals, among which might be mentioned "The Corrosion of Brass Condenser Tubes" by Mr. Paul T. Bruhl. This paper is the result of a thorough study of this troublesome problem, and brings out certain very interesting conclusions arrived at by the author. "In this connection attention should be called," says Carl F. Woods, of the staff of Arthur D. Little, Inc., chemists and engineers, of Boston, "to the proceedings and the report of the corrosion committee of the Institute, which was opened a year ago with a view to carrying out an exhaustive and authentic research on the corrosion of brass and bronze. The committee have decided to erect in Liverpool a plant in which the conditions of marine condenser service should be as closely imitated as possible. The plant is to consist essentially of four cast-iron tubes, each fitted with tube-plates to carry twelve condenser tubes, these iron tubes representing four small independent condensers. The condensers will be connected direct to the exhaust of a small engine, which in turn will drive a circulating and vacuum pump for circulating sea water through the condensers. Each condenser will be fitted with the same kind of tubes, and the committee has decided for the first set that one condenser shall be equipped with the so-called "Admiralty" mixture with a tube plate of naval brass, the equipment being carried out with the same extreme care insisted upon by the "Admiralty" practice. The second condenser will represent the best class of commercial practice, the tubes being 70-30 mixture and the plates of yellow metal. The exact equipment of the other two condensers had not been decided upon at the time of the committees progress report, but they will be compositions representative of commercial practice. The results obtained from careful experiments carried out in this way should be of the utmost value, as it should be possible to practically duplicate service conditions and at the same time to control the various conflicting conditions in such a way as to arrive at definite, well-founded conclusions

POWER SUPPLY ON THE RAND.

By A. E. Hadley, M.I.E.E.*

[NOTE.—The Victoria Falls and Transvaal Company, Limited, was formed at the end of 1906, with the object of supplying power in South Africa and Rhodesia, and of acquiring the concessional rights to develop the Victoria Falls. Mr. Hadley read a paper on this power development work recently before the Institution of Electrical Engineers, Great Britain, and it is an abstract of this paper which we publish below.—Ed.].

Under the original proposal a supply to the Rand was to be given partly by transmitting power from the Victoria Falls, 700 miles distant, and partly by steam generating stations located on the reef. The author became associated with the company shortly after its formation, and after its original proposal had been modified through giving up the plan to supply part of the requirements of the Rand with power from the Falls.

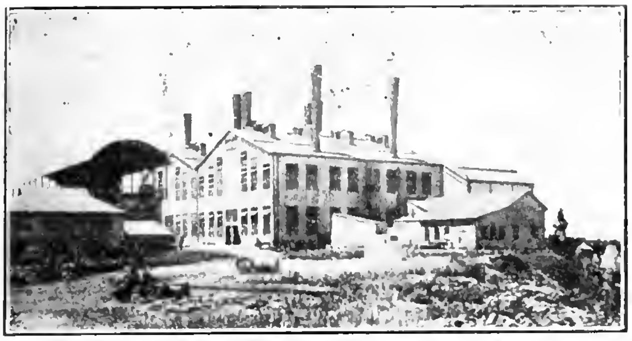


Fig. 1.—Exterior of Generating Station at Simmerpan.

The great demand for power on the Witwatersrand has arisen through the extraordinarily successful development of the gold mines on the reef, which, although only discovered in 1886, now produce 33 per cent. of the world's output of gold. Further, it is estimated by the leaders of the gold-mining industry that the work of raising gold will still be in progress on the Rand 100 years hence.

Turning for a moment to the history of electric power on the Rand, a few details will be of interest. Siemens and Halske were the first to obtain a concession in 1894, and formed the Rand Central Electric Works, Limited, in 1895, which had a plant aggregating 3,200 kw. capacity in 1906. Another concession was obtained by the Simmer & Jack mine in 1897, from which the General Electric Power Company was estblished in 1906 with plant having a capacity of 2,500 kw. In 1905 Messrs. Lewis & Marks, having in view the possibility of supplying the Rand from their coal-fields at Vereeniging, 35 miles south, commenced obtaining way-leaves for a pole line, while certain European manufacturing companies sent out representatives to report on the prospects.

The Victoria Falls Company ultimately took over the two existing supply companies in 1907, and purchased the Vereeniging wayleaves from Messrs. Lewis & Marks, at the same time entering into an agreement with them for the right to establish a power station at Vereeniging. In 1907, pending the installation of modern plant, a supply totalling 4,000 kw. was given from the existing steam stations which had been purchased.

As soon as it was appreciated that a cheap power supply was available the mining groups entered into contracts with the company, and the demands for power have since increased so quickly that it has throughout been the greatest difficulty for the company to raise capital and install plant rapidly enough to satisfy the demand.

In 1908 the largest group of mines, viz., that controlled by the Rand Mines, Limited, and Messrs. Eckstein & Company, decided to change over their mines to electric driving. In addition to the supply of electricity to this group of mines, the conditions called for the supply of compressed air for working the rock drills.

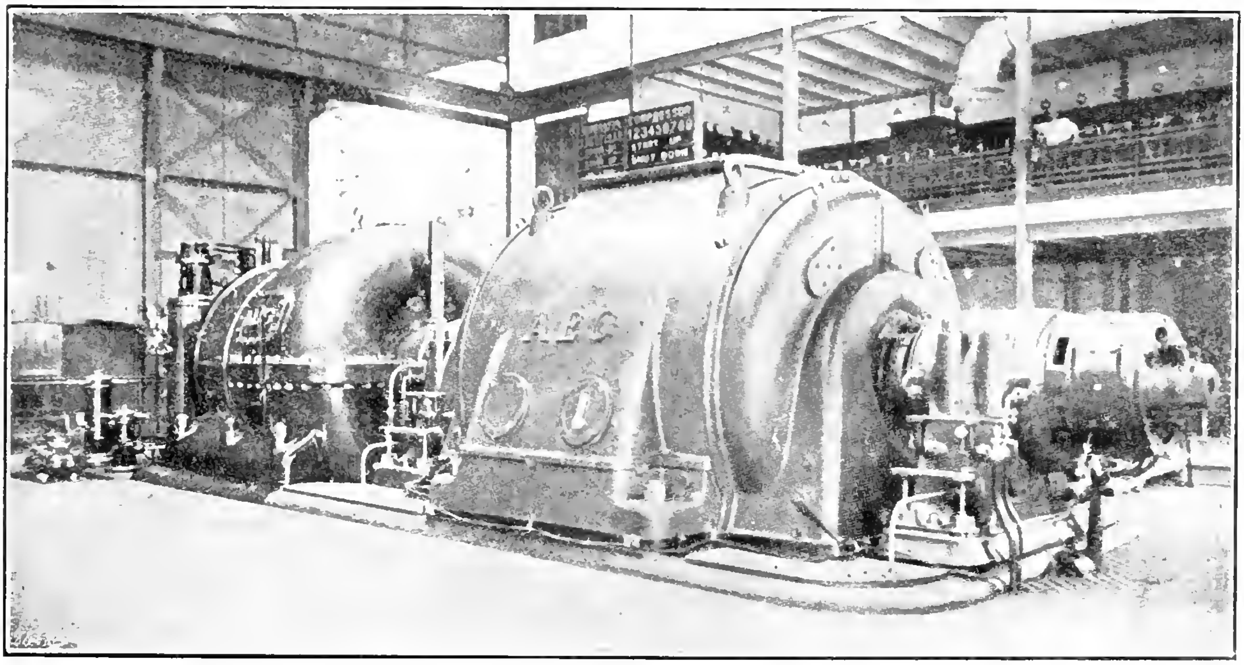


Fig. 2.—Turbo-Generator of 12,000 k.v.a.

The peak load of the combined undertaking has reached 88,000 kw., and the sales average 1,350,000 units per day. These figures include the sales of compressed air to 10 mines. The air units represent practically the same amount of energy as if these 10 mines had converted their compressors to electric drive and purchased electricity. When the further

* Managing Director of the Victoria Falls and Transvaal Power Company.

demands for power which have already been notified are met by the plant now on order, the sales will reach 2,000,000 units daily. The monthly load factor, based on the hour of maximum output, varies from 70 to 74 per cent.

The supply is furnished to all mining consumers at 2,100 volts and 525 volts. The necessary step-down transformers and switchgear are provided by the power company, while the consumer supplies the sub-station building and pays the power company a sum equal to 2 per cent. of the power bill to cover the losses in the step-down transformers.

The standard price in mining contracts covering not less than 12 years is 0.525d. per unit, as long as the monthly load-factor is above 70 per cent., the load-factor being based on the hour of maximum consumption. This price is subject to periodical revision depending upon the cost of production, and further, a participation with the consumers in the profits of the business after a due return has been paid on capital is also provided for. In case of failure of supply the consumers are entitled to a payment from the power company of 7s. per hour for each 100-kw. put out of commission.

The introduction of these prices on the Rand has reduced the cost of power to the mines by 40 per cent., and has reduced the cost of production of gold by an amount varying from 6d. to 1s. per ton of ore milled. It has further resulted in considerable saving of capital expenditure on plant, which in the case of a new mine may amount to £100,000.

The area over which a power supply has to be given lies within a strip about two miles broad and stretching 50 miles from east to west. The total power used by the mines at the present time is estimated at about 400,000 horse-power.

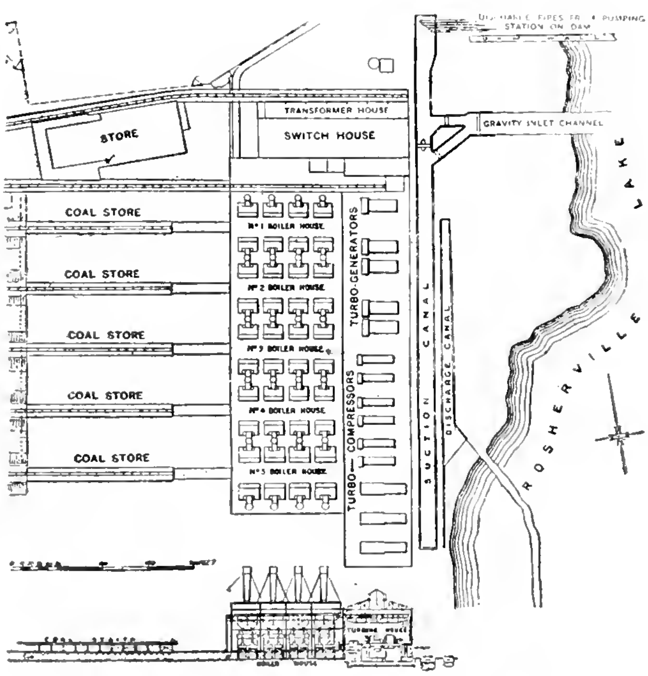


Fig. 3.—Plan of Rosherville Power Station.

Power plants aggregating nearly 180,000 kw. have been installed in, or are under construction for, the stations enumerated in the table given at the end of this article. They are set out in the order in which they were built.

At Robinson Central air station there are also six electrically driven air compressors, each of 3,500-kw. capacity.

At all stations steam turbo-electric generating sets are employed, and produce three-phase energy at 50 cycles. Step-up transformers raise the generator pressure to 40,000, 20,000 or 10,000 volts, and their interposition gives additional security to the machines against pressure rises. This method, in which the generator voltage is optional, gives the further advantage of enabling the stators to be constructed with the bar winding having one bar per slot.

The main system of transmission is effected by means of 40,000-volt overhead lines stretching practically the whole length of the reef. At the present time, however, the western extremity is working as a 20,000-volt distribution line. Where the load is most dense the transmission consists of two rows of towers, each arranged to carry two circuits.

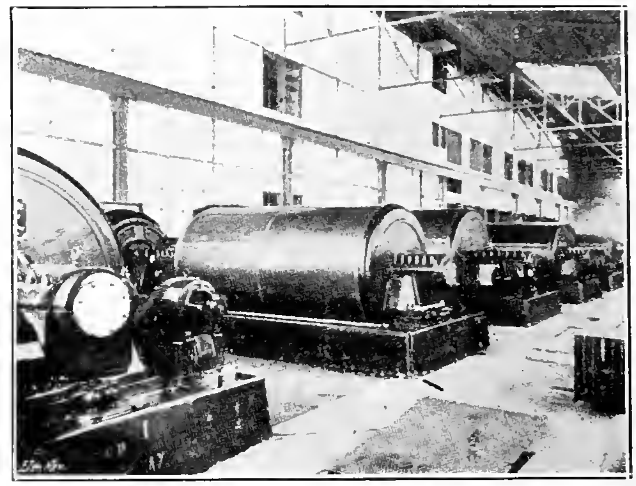


Fig. 4.—Air Compressors at Robinson Central Deep.

The 40,000-volt transmission system is fed at Brakpan, Simmer Pan, Rosherville, and at Robinson Central, where the supply from the Vereeniging station joins the reef. In addition to these distribution stations the transmission lines pass through two further distributing centres at Hurcules to the east and Bantjes to the west. From these six points distribution networks, laid out as ring mains, supply the various sub-stations on the mines. The three eastern distribution stations supply the system through 10,000-volt overhead lines. The central portion of the area is served by an underground 20,000-volt cable system.

The Vereeniging station is connected to the Rand by an 80,000-volt line approximately 35 miles long, terminating at the Robinson Central distribution station, where the pressure is transformed to either 40,000 or 20,000 volts, these pressures being also coupled together through transformers aggregating 16,000 k.v.a.

All transmission and distribution circuits, with the exception of the long-distance 80,000-volt lines, are equipped with the Merz-Price balanced relay system for automatic switch control, without which a reliable supply on the ring-main system could not have been given, and the more expensive radial type of network would have been necessitated. This balanced relay system is also employed for the protection of all transformers and for the large generators. The pilot wires for operating this system on the 40,000-volt transmission lines are combined with telephone circuits in a lead covered cable suspended overhead, while on all distribution networks (both overhead and underground) combined pilot and telephone cables are laid underground.

A special feature of the lay-out of the telephone system is the arrangement whereby the control of all switching and the control and regulation of load, voltage, power factor, and other operating conditions, are in the hands of the control department.

One control engineer or load dispatcher is responsible for all routine switching and linking carried out at any point

on the electrical system during his shift, and under the regulations no switching can be carried out without his consent. The load dispatcher, as soon as any switching has been carried out, adjusts a large diagram in the control room so that it shows every connection on the system.

When the contract with the Rand Mines, Limited, was concluded the site for the station was selected at the Rosherville Dam, which is the largest lake on the Rand. This station will shortly have a capacity of nearly 100,000 kw. of plant installed. After the new extensions are completed the turbine room will be 450 feet long and 75 feet wide, and there will be five right-angle boiler bays, each containing eight boilers. The general lay-out is shown in Fig. 3.

The coal-storage arrangements are very complete, the coal being discharged from a height of 14 feet through the floors of 40 ton railway trucks into outside storage bunkers, under which coal conveyers are arranged. The whole structure is open, as roofing is unnecessary, owing to the favorable climatic conditions.

The conveyers, each capable of dealing with 40 tons of coal per hour, run in tunnels under the external coal store, and are fed with coal by gravity through shoots from the coal pile above. These conveyers are kept running practically continuously, allowing the internal coal bunkers in the boiler house to be of small capacity. An automatic tip is fitted over the bunkers, which tips the conveyer buckets when the coal in any particular bunker has fallen below a certain level. Weighing machines are installed in the conveyer tunnels, and the coal is weighed as it passes in the conveyer buckets.

The ashes are discharged from the rear of the stokers into hand trucks in the basement, where natives push the loaded trucks out and attach them to a motor-operated rope haulage leading to the ash dump. The question of removing these ashes by suction is at present under consideration.

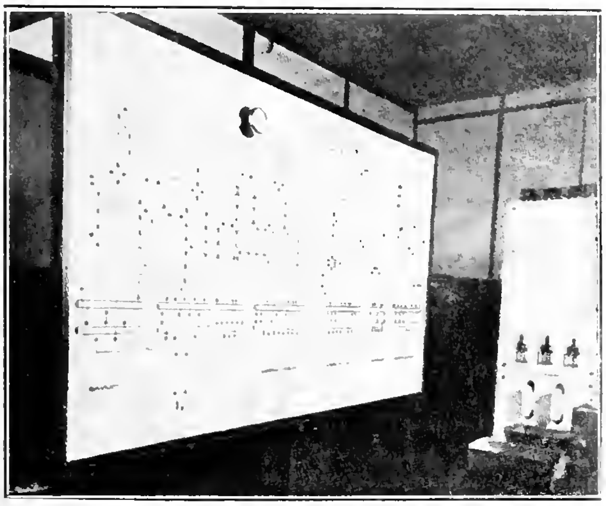


Fig. 5.—Load Dispatcher's Diagram.

The class of coal burnt at this and other Rand stations is mostly the small coal from the collieries in the Middelburg district, 60 miles distant, mixed with a proportion of the duff produced by the coal-cutters. The coal has an average calorific value of about 11,000 B.th.u. per lb.

The large percentage of ash, viz., 18 to 25 per cent. of the coal, and the high load factor at which the plant is operated, necessitated a combination of boiler, superheater and economizer that would give the highest possible efficiency; the high cost of white labor, and the inefficiency of that of the native, also required that the plant should be mechanically operated.

In view of these considerations, and the great cost of constructional work in South Africa, the injector system of induced draught originally devised by Mr. Prat has been adopted in all the power stations. The system has been found to give the utmost satisfaction.

In the lay-out employed, adjacent boiler units are connected to a common ejector chimney, the top of which is 90 feet above the boiler-house floor. An electrically driven rotary fan, capable of developing 75 h.p., blows cold air

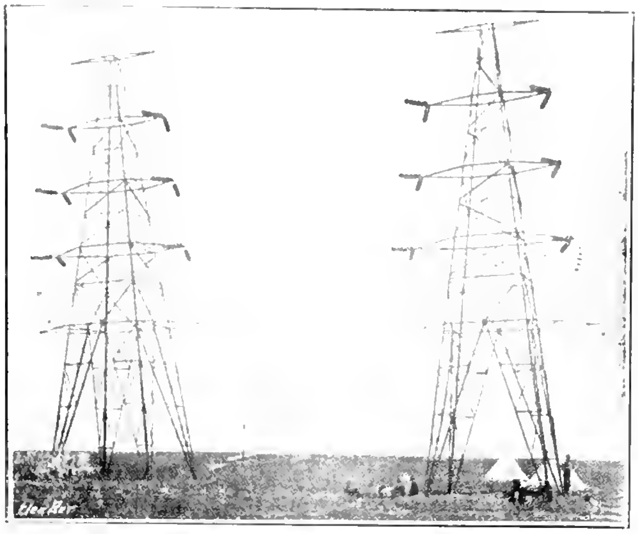


Fig. 6.—Double Tower Line at 80,000 Volts, and Construction Camp.

through the ejector situated in the chimney, thereby producing the necessary suction in the flues, and a draught of about 1 inch is usually employed.

With this arrangement great flexibility in the boiler house is obtained, and by the use of a torpedo-shaped damper in the air pipe regulating the pressure of the air jet, the duty of the boiler unit can be easily regulated to suit fluctuations in the load. The plant is absolutely smokeless, and it is difficult by looking at the ejector chimneys from outside the station to tell which boilers are at work.

The boiler unit selected is the Babcock & Wilcox marine type, fitted with chain-grate stokers, each having an integral superheater and economizer. The boilers are arranged in two rows in each boiler house, with a central and common firing floor. Each boiler has a rated capacity of 32,000 lb. of steam per hour at a pressure of 220 lb. with a temperature of feed water of 100 deg. Fahr., and is capable of producing 38,000 lb. of steam without undue forcing. The heating surface of the boiler is 5,520 square feet, of the superheater 1,720 square feet, and of the economizer 2,200 square feet. A six-hour test on one of the boiler units gave a combined efficiency of boiler, superheater, and economizer of 80 per cent.

The turbine room at present contains five turbo-generators each of 12,000 k.v.a. (Fig. 2) and six steam compressors each having an input of 3,500 kw.; three more steam compressors each taking 7,030 kw. are also being installed. The turbines are of the A.E.G.-Curtis horizontal type, having one high-pressure wheel with three rims of blades. The admission pressure at the intake nozzles is brought down from 220 lb. at a temperature of 300°—350° C. to about 20 lb. with a superheat of about 20° C. In the low-pressure portion of the turbine, the steam is expanded through 12 stages. Both

hand and motor regulation of the speed are arranged for. The total weight of a 12,000-k.v.a. turbine set, including condenser and pumps, is 370 tons.

The stators of each of the six-pole generators are bar wound, having one bar per slot. The machines running at 1,000 r.p.m. produce 50-cycle three-phase energy at 5,000 volts, which is stepped up to either 10,000, 20,000, or 40,000 volts, by transformers directly connected with the stator terminals.

The rotor coils are lined with metal casings before being attached to the rotor by dovetailed grooves and wedges. The rotor carries a ventilating fan at each end. The frequent dust storms in South Africa charge the air with heavy particles which might prove dangerous in the ventilation of the machines, consequently each machine is provided with an air filter having an effective surface of fireproof cloth of 8,000 square feet. Each turbine set is provided with a direct-driven exciter, while a stand-by supply is also available from a motor-generator and battery.

The condensers have a cooling surface of 17,750 square feet; each set has a centrifugal circulating pump of about 663,000 gallons per hour capacity, and a centrifugal air pump, both connected on one shaft and driven direct by a steam turbine. The exhaust from the auxiliary turbine is taken to the middle stage of the main turbine, where the remaining energy in the steam is utilized down to the vacuum of the condenser.

The water for the condensers and compressor jackets is taken from the lake through a channel excavated along the front of the station, and is discharged into a second canal placed alongside the intake; this canal delivers the warm water to the lake at a point as far from the intake as possible. Under normal conditions of water levels the intake water flows by gravity into the service canal, but in order to deal with periods when the water in the lake may be low, a pumping station has been erected half-way along the dam wall at the deepest part of the lake.

The boiler feed pumps are of the turbine-driven centrifugal type, and are installed in the turbine room. With the exception of certain electrically-driven bearing-cooling pumps, all auxiliaries are turbine-driven.

The generator transformers are connected by cables to their corresponding generators, and are each of 12,500-k.v.a. capacity. Where larger transformers have been required, as for the last two sets at Vereeniging, two transformers for each machine have been installed. The transformers at Rosherville are of the shell type and water-cooled, the windings nearest the terminals being specially insulated to withstand between adjacent turns a pressure of 25,000 volts for five minutes. A test pressure of 160,000 volts was applied to the whole of the windings. The weight of each transformer complete without oil, is 50 tons; the oil itself weighs 21 tons.

The steam turbo-compressors at Rosherville are similar to the motor-driven compressors at Robinson Central, and are each designed to deal with 22,000 cubic feet of free air per minute with an outlet pressure of 9 atmospheres (absolute). The power required on the shaft is, roughly, 3,500 kw. In the case of electrically driven sets at Robinson Central each unit is divided into two halves on separate shafts, each motor having a capacity of about 2,000 k.v.a., and being designed to operate at full load at a leading power factor of 85 per cent. The sets run at 3,000 r.p.m. The steam-driven compressors are arranged in two sections on the same shaft with an intercooler between them. The cooling water required for the jackets of the compressor and intercooler amounts to about 40,000 gallons per hour. The air leaves the compressor at a temperature of about 70 deg. C.

Between the compressor and the pipe line an automatic non-return valve is fitted, which allows a compressor to drop out to atmosphere when its pressure falls below that of the air system.

By the use of the rotary compressors the air entering the pipe system is kept entirely free from oil and other impurities liable to be introduced into the air system when piston compressors are employed. The speed regulation of the steam turbo-compressors is automatically controlled by the pressure in the air pipes. The regulation of the electrically driven compressors at Robinson Central is effected by throttling the intake. The weight of a turbine-driven compressor, condenser, and pumps is 180 tons.

The switchgear is laid out in a building at the southern end of the station, and the step-up transformers are in cubicles arranged along the outer side of the switch-house. The last-mentioned is constructed with four floors: the upper floor contains the lightning-arrester gear, the third floor the bus-bars, the second floor the 40,000 and 20,000-volt oil switches, whilst the lower floor is occupied with cableways and pipe passages. Duplicate bus-bars are installed for both the 40,000 and 20,000-volt systems, the various oil switches being provided with knife selector switches to connect to either bus-bar. The 40,000 and 20,000-volt systems are connected together through coupling transformers. The switches consist of three single-phase coupled switches operated from a remote-control board.

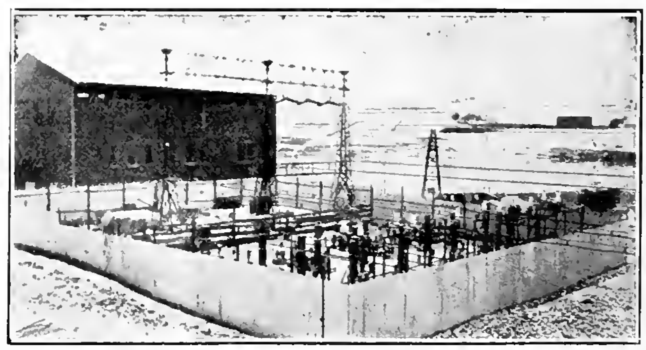


Fig. 7.—Lightning Arresters, Etc., at End of 80,000-volt Line.

Since the Rosherville station came into commercial service, troubles have been experienced owing to failures of switches on short-circuit. When the Brakpan and Simmerpan stations were started to supply the 40,000-volt transmission and also the 10,000-volt local lines, their total capacity was 24,000 kw., and no trouble was experienced when a short-circuit occurred on the system. When, by the addition of Rosherville, the system grew to 60,000 and 70,000-kw. capacity, switch breakdowns occurred, conclusively proving that no apparatus was available which could be relied upon to interrupt the immense rush of current occurring on short-circuit.

Some serious line interruptions have in the past been caused by the wilful throwing of bare wires over the lines. When this form of short-circuit has occurred near a power station, apparatus has usually been lost.

Dynamos running at a high speed have a low internal reactance. The step-down transformers in the present case were designed with a low reactance to give good regulation, so that probably the total reactance in circuit on a short-circuit was about 7 or 8 per cent. The momentary rush of energy on short-circuit could therefore reach the tremendous

proportions of 500,000—700,000 kw. No oil switch, as at present designed, could interrupt this rush of power unassisted. The intensely hot gases formed by the arc, after rising through the oil, come into contact with the air and cause an explosion, which, more often than not, is productive of a switch failure.

About the time that this trouble became apparent on the Rand, exactly the same difficulty was being experienced on stations of similar large output in America, and the problem was vigorously tackled over there. Many methods have been tried at Niagara, Chicago, and other places, and it has become generally recognized that it is necessary to insert additional reactances in order to limit the rush of energy on short-circuit. In certain cases this precaution has proved entirely satisfactory. In others additional methods for assisting the oil switch have been necessary; such as (1) sectionalizing the system on to separate bus-bars and limiting the amount of machinery that would be affected by one short-circuit; (2) the placing of two switches in series timed so that one opens first and inserts a non-inductive resistance, the circuit being actually broken by the second switch; (3) the use of a special type of switch having two moving systems, one of which first introduces reactances, and the other then breaks the circuit.

These methods have been tried on the Rand. The earthing of the neutral through a resistance has proved most valuable, as more than 90 per cent. of the faults start as faults to earth. At Rosherville and Vereeniging reactances having a value of about 6 per cent. have been installed between the dynamos and the step-up transformers. The latest practice is to design both generators and transformers required for power service with large internal reactances.

At Vereeniging and at the Rand end of the 80,000-volt line two systems of switching have been installed. On the first two Vereeniging machines two switches are employed in series, one introducing a non-inductive resistance; while on the last two machines, both of which have not yet been put into service, a two-movement reactance switch is being installed. This switch is constructed on the lines of an oil-break switch, but is provided with a second pair of contacts for the final break. The separation of the first pair of contacts introduces two reactances placed centrally one on each terminal bushing inside the oil tank, and the second pair of contacts finally breaks the circuit.

At some early date the system will also be sectionalized in order to reduce the rush of power on short-circuit, and in doing so reactances of relatively large value can be inserted between sections in those cases where it is not economical to separate adjacent sections permanently.

This problem of switchgear for dealing with enormous rushes of power has proved one of the most difficult that has been encountered so far on the Rand and also in America. It has not yet been finally solved, nor have switches been standardized which are capable of dealing unassisted with these exceptionally severe service conditions. These remarks on switchgear apply not only to the central stations, but also to the distribution stations, and in a less degree to the consumers' sub-stations.

The electrical supply at 2,000 volts and 550 volts to the consumers' premises is effected from step-down transformer stations, which are built by the consumers, but are equipped with switchgear and transformers by the power company. (Fig. 8). There are 60 of these consumers' sub-stations connected to the system, and their individual capacity varies from 10,000 k.v.a. to 2,000 k.v.a., the normal size being 5,000 k.v.a.

The standard sizes of consumers' transformers are 1,000, 500 and 250 k.v.a., designed with the primary windings arranged for either 20,000 or 10,000 volts. A temperature rise of 40 deg. C. is allowed above an air temperature of 40 deg. C. The windings near the outgoing terminals will stand a pressure of 15,000 volts between adjacent turns. The high-tension windings are tested to the secondary windings and core with a pressure of 40,000 volts, and the insulators with 60,000 volts. The transformers have been supplied by Messrs. Siemens, the Allgemeine Elektricitäts Gesellschaft, and the Westinghouse Company.

The transformers are exported filled with oil, thereby reducing the cost of transport and dispensing with the necessity of drying out after erection. In order to allow for the expansion and contraction of the oil each transformer tank is connected with a second smaller tank fixed on the wall of the sub-station. This expansion tank is fitted with a vertical vent-pipe, so that only a small surface of oil is in contact with the air, and by this means sludging is prevented. Each

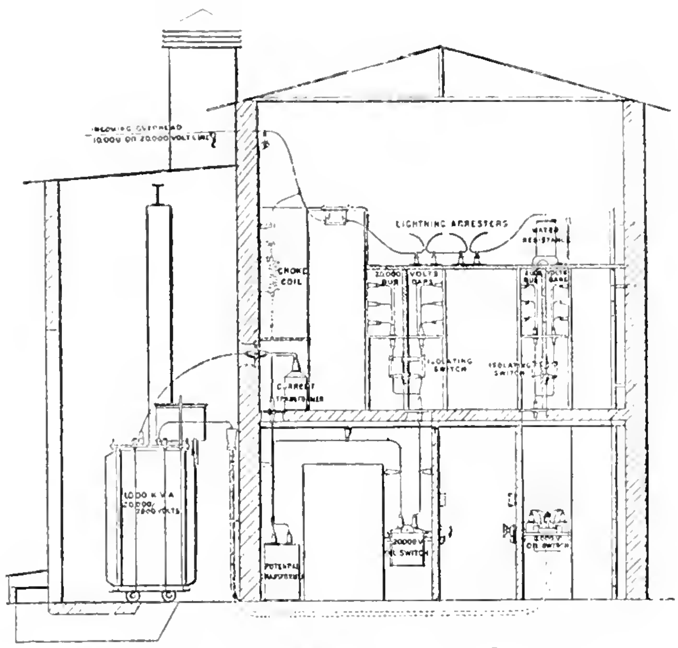


Fig. 8.—Section of Standard Type of Consumers' Sub-station.

sub-station chamber has a short stack, which induces a natural draught and provides effectual ventilation. Double bus-bars are provided for each voltage. The high-tension and low-tension switchgear in each sub-station is arranged in different chambers with a central operating passage between containing no "live" material. The "live" chambers are locked, and stringent regulations as to the possession of the keys ensure that no unauthorized person can obtain access; in no case is one man allowed to enter alone. The total capacity of the transformers in operation, including generator transformers and coupling transformers, is unusually large, amounting at the present time to 450,000 k.v.a.; but this will be increased to 508,600 k.v.a. when the transformers delivered and on order are brought into commission.

The company realize the importance of welfare work and its influence on the conditions of the life of the staff. They give a generous support to recreation and sport, and facilitate in every way the promotion of social intercourse among all classes of the employees.

Some 60 residences and quarters have been built by the company at the various power stations, and at each station

a boarding house and recreation rooms are provided. Generally speaking, the conditions of life compare very favorably with those of an engineer on the mines. A fleet of 14 motor-cars is maintained in constant service for the use of those officers and engineers of the company whose duties necessitate visiting the different parts of the system. A special department handles the entire transport of materials, and employs constantly two motor-lorries and 50 mules and horses.

Name of station.	Total capacity of electric generating plant installed.	Steam-driven air compressors installed.	Extensions in progress.
Brakpan	Two 3,000-kw. sets	—	—
Simmerpan	Six 3,000-kw. sets	—	—
Rosherville	Five 10,000-kw. sets	Six 3,500-kw. machines	Three 7,000-kw. steam-driven air compressors
Vereeniging	Four 10,000-kw. sets	—	—
Extensions in 1913.	—	—	Two 10,000-kw. sets
——	114,000 kw.	21,000 kw.	41,000 kw.

Total capacity of plant installed and in progress, 176.000 kw.

ELEVATORS ON PACIFIC COAST

Prince Rupert is to make a bid for the wheat traffic that will come to the Pacific coast from the prairie provinces. Mr. J. E. Dalrymple, third vice-president of the Grand Trunk Pacific, has announced to the board of trade of the northern city, that an elevator with a capacity of ten million bushels is to be erected on the townsite and that construction will start shortly. This is really the first definite announcement of the construction of big wheat elevator on the Canadian Pacific coast, with the intention of looking after the trade that is expected. There has been talk of many in and around Vancouver and New Westminster. Mr. Dalrymple's statement is definite, and shows that the Grand Trunk Pacific will have some of the trade from Western Alberta when its line is completed. The Canadian Pacific Railway at this point will also get busy when the time comes, so it can be taken as granted that elevators will be erected in the neighborhood of Burrard Inlet in due course. Officials of the railway have stated the traffic will be taken care of when it arises, and naturally they will do what they can to increase business.

A number of leading officers of the Great Northern and Northern Pacific Railways have been on the coast during the past week. A stated time is now given when the Northern Pacific will have its own tracks into Vancouver, that is, as far as Cloverdale on the south side of the Fraser River, thence by Great Northern Rails into Vancouver. A joint depot with the Great Northern is spoken of. There has also been a slight hint that the Great Northern would link with the Canadian Northern in a big depot at the head of False Creek. The suggestion is reasonable, for if two depots are erected they will be quite close together, and one large depot would serve the purpose better. But, as one of the officials remarked, it is three years yet before filling in operations will be completed, so there is plenty of time to figure out about the depot.

SOME QUALIFICATIONS REQUIRED OF AN ENGINEER.

By Prof. E. Brydone-Jack, B.A., C.E.*

The following extracts from an article in the Manitoba Engineer for March, 1913, will no doubt be read with interest, especially by the younger men in the profession:

The opportunities opening up to young engineers to-day are more numerous and varied than ever before. We find them taking up the business part of their profession as well as the technical part and holding positions as managers, superintendents, presidents, etc., of large corporations.

If the engineer is to take advantage of these opportunities, how must he be prepared, what are the necessary qualifications in order to attain success?

Evidently knowledge of theory is not the only qualification required, knowledge of practice is not the only qualification required. It is essential that the engineer should possess the knowledge of both theory and practice, but in addition to these he must have character and judgment.

Character and judgment are qualities which determine an engineer's advancement just as much as and perhaps more than his technical knowledge. It is no uncommon sight to see men with an excellent knowledge of both theory and practice occupying subordinate positions, while those with less knowledge but with more executive ability are placed over them.

The engineer is measured and advanced according to his efficiency. True efficiency can only be obtained by a combination of technical knowledge, character and judgment. It is essential that the engineer should learn thoroughly the fundamental principles upon which is based the particular branch of engineering which he is to follow, and that he should have the power to apply them intelligently and correctly. He should be able to observe accurately and reason logically from premises gained by observation or otherwise. His character should be such that his word and honesty can always be relied upon and that he should realize the ethical principles which should govern a man's acts in this world and which should regulate his conduct towards his fellowmen.

His judgment should in all cases be unbiased and depend entirely upon the facts presented. This implies reasoning power and ability to reach logical conclusions.

These qualifications may perhaps be best summed up in the "Specifications for a Good Engineer" in Chief Engineer Starling's report to the Mississippi Levee Commissioners, which are as follows:

"A good engineer must be of inflexible integrity, sober, truthful, accurate, resolute, discreet, of cool and sound judgment, must have command of his temper, must have courage to resist and repel attempts at intimidation, a firmness that is proof against solicitation, flattery or improper bias of any kind, must take an interest in his work, must be energetic, quick to decide, prompt to act, must be fair and impartial as a judge on the bench, must have experience in his work and in dealing with men, which implies some maturity of years, must have business habits and knowledge of accounts. Men who combine these qualities are not to be picked up every day. Still, they can be found. But they are greatly in demand, and when found, they are worth their price; rather they are beyond price, and their value cannot be estimated in dollars."

* Professor Civil Engineering, University of Manitoba.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, MAY 15, 1913. No. 20

CONTENTS OF THIS ISSUE.

THE METER AS A FACTOR IN ELIMINATION OF WATER WASTE.

Within the past few years a phase of municipal engineering that has attracted more than passing interest is that which has to do with the control of public water supply for domestic purposes. In some cases municipalities are supplied by private companies, while in others the system is controlled by the municipality and run as one of its branches of the administration. In either case the problem of supplying the water to each individual on an equitable and fair basis is a very real one, and it would seem that the only satisfactory solution of the problem is the adoption of the meter system.

The waste of water that goes on in many municipalities in many cases is appalling, and in some instances positively criminal. Statistics show that the amount of water wasted during the winter months with the sole object of preventing freezing of pipes is equal to six gallons per day per capita for the entire year. While this waste is allowed to continue it most effectively prevents the enlargement of works and the attachment of new sources of supply at great cost, for almost all statistics show that could the waste of public water be brought down to its minimum, the question of an adequate supply dependent upon enlarged uses and the increase of population would practically be adjusted.

While there have been many arguments against the more general introduction of the meter system, such as references to the unlimited supply of water and its effect upon health, etc., it is a fact that the meter system stands to-day an unqualified success and the only logical solution of this very vexed question.

Looked at from the viewpoint of economics the usefulness of the water meter is unquestioned. Its value in this direction has been demonstrated time and time again. On the other hand, there are some cities in which influences are constantly at work looking to the prevention of their introduction. This will probably always be the case, but the fact remains that the only sensible way to check this enormous waste is by the introduction of the water meter.

THE ENGINEER AND HIS READING.

While, perhaps, the engineer is not more negligent about what he reads regarding what is going on in his profession than many other classes, the fact remains that too many engineers leave our universities with the impression that while at university it was proper he should read, and read much, when he gets out into the field it is work that is called for.

In this day of rapid changes the realm of engineering is no exception, and it behooves the technically trained man to see to it that he does not neglect the opportunities which are afforded him of securing information generally covering the latest practice in all branches of engineering, and particularly the one in which he is most interested. In fact, he is likely to be a better engineer if some of his time is given over to the study of other phases of engineering than the one in which he is specifically interested at the moment.

In order to keep himself posted concerning developments going on in engineering practice, he should most assuredly, in addition to relying on his text-books, spend some time in reading the current technical papers. He should come to realize the importance of knowing what the man is doing who is engaged in the same class of work as himself; in other words, he must modernize his

practice; be aware of the progress his profession is making, if he is to be in a position to adopt new ideas and new processes and apply them in his own daily work. He will get such service by a careful reading of the leading technical journals covering the profession of engineering. While a man may succeed, and succeed to a very unusual degree as an engineer without the help which the technical press can afford him, it is fair to assume, other things being equal, that the man who is posted in relation to his work, due to a careful study of technical journals, which show him how the other man is attacking and accomplishing certain results, will make an even greater success.

It is particularly important that the younger engineer just beginning his career make it a practice to read such papers as most adequately cover the particular branch of engineering he is to specialize in, and, where necessary, make a practice of clipping those articles which are of particular interest to him, and which are likely to prove of value in the days which are to come, and which will doubtless have a direct bearing upon his work.

THE WATERWORKS OF CANADA.

Through the courtesy of the Commission of Conservation we have received a copy of a report compiled by Leo. G. Denis, Hydro-Electric engineer of the Commission of Conservation, in which is given a very large amount of valuable data covering the waterworks systems now in existence throughout the Dominion of Canada. The report includes detailed information concerning something like 360 plants, as well as a table showing the number of sewage disposal plants in Canada, which information has been tabulated from data compiled by the committee on sewage disposal of the Canadian Society of Civil Engineers, 1911-1912. The information relating to each waterworks is given under the name of the city, town or village, it being arranged alphabetically under each province, while the provinces are arranged geographically from east to west. The information given has been arranged in a very concise and convenient form, and it is hoped that it will prove valuable to all who are interested in water supply generally. Not only that, but it will also help those directly connected with waterworks systems to become better acquainted with conditions relating to other plants than their own. The report contains a number of valuable charts summarizing the information gathered, and altogether is a very valuable addition to the statistical literature covering this very important phase of the civil engineer's work.

EDITORIAL COMMENT.

A most interesting and valuable symposium on the subject of expert advice comes to this office in the form of a verbatim report of a discussion held at a meeting of the American Institute of Consulting Engineers when that subject was the topic. That the need of better and more intelligent methods of securing expert evidence is called for is evident, and the subject is one that should have great interest for the engineering profession. Those interested may secure a copy of the brochure by addressing a letter to Eugene W. Stern, secretary American Institute of Consulting Engineers, 101 Park Avenue, New York.

With the announcement from Ottawa this week that tenders for the building of the first section of the Welland Canal will probably be called for toward the end of this month, one is struck with the fact that Canada is more and more being confronted with engineering projects that a few years ago would have been considered unlikely. The writer recalls being in the office a very few years ago of one of, if not perhaps the largest, engineering contractor in Great Britain, a man who was at the head of a contracting organization whose activities extend to almost every part of the civilized world. He was asked why it was he gave little or no attention to Canada as a field of operation. He answered to the effect that Canada was yet of insufficient importance to justify his giving it his attention owing to the absence of large projects of an engineering nature. It is interesting to note that that particular firm, as well as two or three others in the same class, now have very aggressive organizations in Canada and are actively bidding for work here. It is pleasant to record a fact such as this. Large work means large responsibility. Our various engineering schools throughout the Dominion will no doubt rise to the occasion and see to it that the type of engineer turned out is equal to the challenge which this day of larger things in engineering in Canada gives him.

* * * *

We beg to acknowledge the receipt of the first issue of the journal of the Regina Engineering Society. This publication, as is stated in the introduction, "symbolizes the spirit and enterprise of the West having for its object the welding of the engineers of the province into a body which shall jealously uphold 'the dignity of the profession.'" To all this *The Canadian Engineer* says "Amen," and hopes that the expectations of the gentlemen responsible for the birth of the Regina Engineering Society and those who are more actively connected with its work will realize their object, which is a laudable one. The journal contains a resumé of the beginnings of this society, the first meeting of which was convened on Tuesday, April 2nd, 1912, and at which fifty engineers were present. During the year there have been about one dozen papers presented, the titles of which indicate the broad scope in engineering which the membership of this society represents. We congratulate the society on its progress, and hope that it will in every sense of the word be successful. It is interesting to note that the following papers have been promised for presentation before the society during the coming months: "Side Hill Grades," by E. W. Murray, B.A.Sc.; "Power and Intensive Cultivation," by A. E. Eisenach; "Compressed Air Water Supply," by F. McArthur, B.Sc.; "Scientific Methods of Designing Streets," by J. R. Ellis; "The Law of Contracts and Specifications," by C. C. Owen, and "Power House Economy," by J. A. Gibson.

On representations made by the Canadian Manufacturers' Association as to the material desired to be submitted, and that more time is required to collect and codify it to the best advantage, the Board of Railway Commissioners has determined that the consideration of reciprocal demurrage and its suggested application in Canada, also what is known as the "Average Demurrage" Plan, should stand until a special hearing to be held at the Central Station Building, Ottawa, Ont., on Monday, June 16th next. Boards of Trade interested may send in their data from time to time as they desire, and present their cases entirely by written arguments.

STOPPING PLANES IN REINFORCED CONCRETE.*

By Edward J. Stead.†

It appears to the writer, from considerable experience of reinforced concrete construction, that insufficient consideration is as a rule given to the determination of positions of stopping planes in this class of work.

Beams and Slabs.—In concreting beam and slab work, it is a common practice to fill up the beam forms to the level of the under side of the slab; then, at a later stage of the work, to follow over with the slab concreting separately. During the interval, the surface of exposed concrete receives more or less injury from dirt, etc., and it has frequently been noticed that the shear reinforcement gets flattened down and knocked out of shape. These circumstances result in a plane of weakness as regards horizontal shearing on the line a—b in Fig. 1. It has further been observed that the stopping planes in the slab concreting are often made vertical over the longitudinal centre lines of beams, as at c—d in Fig. 1.

In this type of design the beams are in general calculated as T-beams; and, notwithstanding the fact that many successful contracts have been carried out in the manner indicated, it is submitted that it is undesirable to make temporary joints in the position shown. No matter how carefully the surfaces are cleaned and roughened, the homogeneity so greatly desired cannot be secured.

To obtain the full value of the area of concrete in compression—i.e., that portion of the beam proper which lies above the neutral axis, together with the width of the slab

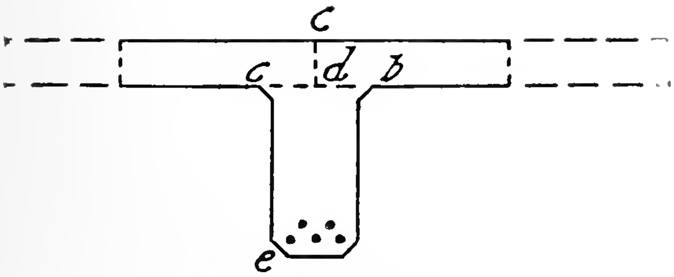


Fig. 1.—Plane Over Beam Centre, Resulting in Probable Weakness in Slab.

acting with it—stopping planes should be excluded, as far as practicable, from that area. Unless the vertical reinforcements in the beams maintain their intended shapes and positions, are rigidly attached to the tensile reinforcement, and well concreted into the compression area, the resulting construction approaches that of a rectangular beam of depth a—e with the slab resting upon it, and the strength will be considerably less than the designer intended.

As a matter of practical construction, stopping planes must occur somewhere in the concrete; and it is suggested that in the case of beams in one direction only—i.e., no secondary beams—the better practice is to cast the beam and slab in one operation, as shown in Fig. 2, in which the dotted lines f—g and h—j represent joint lines parallel with the beams and at the centres of the slabs between them. There can be no serious objection to the joint through the slab, as it is at right angles to the direction of the main reinforcement, the bars of which, being continuous over two or more beams, ensure full tensile strength being availabl[e]. A temporary face-board would be necessary to keep a vertical face of concrete to join up against on resuming. The upper part of the slab being in compression, the action under loading will be simply pressure on the two concrete faces, and the shearing stress at the joint will be nil.

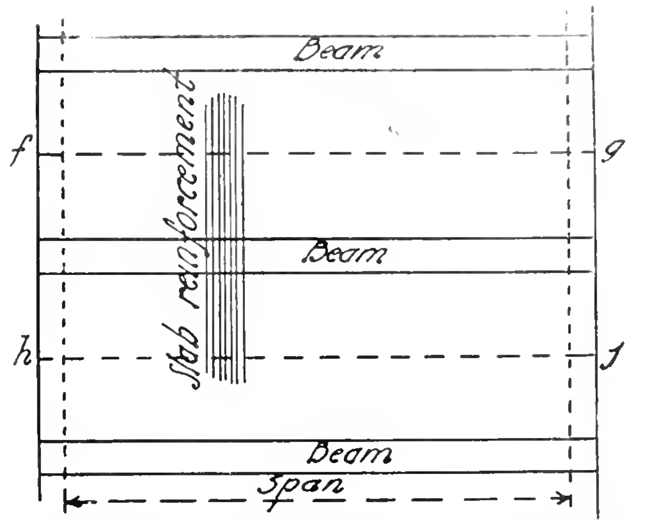


Fig. 2.—Beams Running in One Direction Only—Beams and Slabs Cast as Units—Planes Midway Between Beams.

In constructing larger floors where there are both main and secondary beams, a somewhat similar method is desirable. For the purpose of illustration, a floor has been assumed as in Fig. 3, where the main beams, supported at intervals by columns, run the short way of the building; and between the main beams are the secondary beams, with a slab over all.

Here the main beams and column connections demand special notice, and from theoretical considerations the concreting would be most advantageously carried out in bays across the short way of the building, each bay comprising a main beam and portions of the attached secondary beams and slabs, the joint lines being along the centre lines of slabs and parallel to the main beams, as shown by the broken lines a—a. Complete homogeneity would thus be assured to the main beams and the portions of the slab acting therewith as a T-beam; there would be no break in the work or around

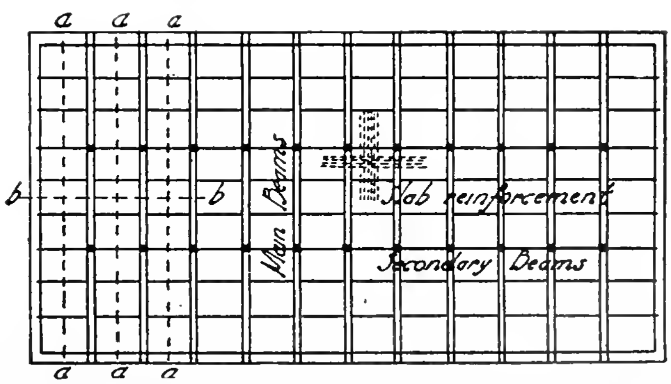


Fig. 3.—Main Beams With Column Supports; Second Beams—Planes on Centre Lines of Slabs, Parallel to Main Beams; also at Centre of Middle Span.

the column heads; and so far as the secondary beams are concerned, the stopping planes would be in the most suitable positions—viz., at the centre of the span and at right angles to the direction of the beam.

---

* From Concrete and Constructional Engineering.

† Associate Member, British Institution of Civil Engineers.

Assuming, however, that the size of the building is such that the volume of concrete in one bay, as indicated, is too great to be put in without a break, it will be necessary, in order to reduce the amount of work to be done in one operation, to make stopping planes through the main beams. The first point then calling for notice is the necessity for avoiding a break at the points of inflexion (which are at approximately a distance of one-fourth the span from the supports), on account of the shearing action at such points. A stopping plane could most advantageously be made at the centre of the middle span—i.e.. in the line b—b.

In no case should concreting be stopped in beams or slabs where shearing stress is likely to be great, as at a point near the supports or under a heavy concentrated load.

It is necessary to fix the whole of the reinforcement in beams before concreting is commenced; but in the case of slabs a common practice is to lay the bars down a few at a time as the concreting proceeds. The adoption of the stopping planes advocated above necessitates the fixing of the slab bars in advance of the concreting—a decided gain as regards accuracy of spacing and the ultimate strength of the work.

Columns.—In general, stopping planes in columns present no difficulty, as they are usually concreted for the full height between floors at one operation. Even if this does not occur, provided the concrete is temporarily left with a horizontal surface, and kept clean and free from foreign matter, no weakness is incurred, as the joint will be at right angles to the pressure upon it.

Arches.—The stopping planes in concreting arches may occur, according to the magnitude of the arch, either longitudinally or transversely. In each case, both the upper and lower reinforcements should be placed and fixed securely in position prior to commencing concreting. Where possible, a strip the full thickness of the arch should be concreted from abutment to abutment in one operation, the temporary joint being made against a profile erected on the laggings, in the case of longitudinal reinforcement only, or, in the case of mesh reinforcement, by short boards set vertically between the meshes, as shown in Fig. 4.

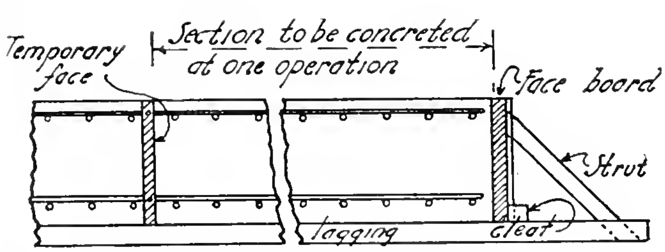


Fig. 4.—Use of Temporary Board Facing in Longitudinal Concreting of Arch.

In concreting sections of the arch transversely, the stopping planes should be at right angles to the line of pressure, or, for all practical purposes, perpendicular to the curve of the arch at the point; and, where possible, it is preferable to concrete a section the full width of the bridge at one operation. The temporary joint in this case will be made against a straight shutter of such depth as to be a very easy fit between the upper and lower reinforcement, such shutter being slipped in from the ends and temporarily secured at the proper angle. On recommencing, the shutter will be drawn out, the face-boards fixed, and concreting proceeded with. The formation of a stopping plane of this description is shown in Fig. 5.

By careful consideration beforehand, the positions of stopping planes ought to be determined and then worked to. Too much emphasis cannot be laid upon the necessity for

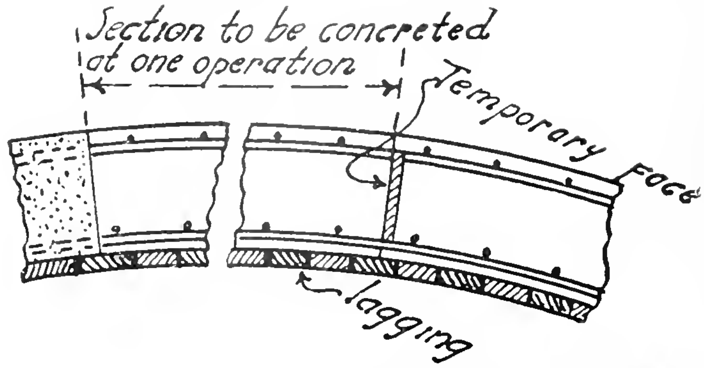


Fig. 5.—Formation of Temporary Joint in Concreting an Arch Transversely.

thoroughly cleaning, roughening, and laying thick grout upon all stopping plane surfaces when concreting is recommenced.

TRADES UNIONISM FOR PROFESSIONS.

By A. B. Howes.

In the study of the history of commerce, trade and manufacture we find that at an early period the advantage of dividing labor into special and distinct branches was realized, and as civilization progressed the adoption of this principle became one of its distinguishing features, and in many ways tended to its advancement. . . . In course of time, as trades became separate and distinct from one another, we find, on the part of the members of each trade, an increasing tendency to unite for the purpose of controlling their particular trade. . . .

Although it is rather a contradictory use of the word, we find that in the past unions among members of a particular profession were, in certain cases, recognized by the Legislature, and were given statutory control over the members of that profession. . . .

That registration is the outcome of modern requirements is abundantly shown by the action of the Colonies in requiring the registration of professions which in the Old Country can be carried on by anyone, although in all probability before many years have elapsed this wise rule will be general in Great Britain as well.

To summarize, the advantages of registration appear to be these:—

The standardization of the qualification of members, at all events as regards a minimum qualification.

Powers of discipline over the members in regard to their professional conduct; powers which are especially effective where such conduct is not within the purview of the law.

Regulation of fees paid to members of the profession.

A closer union in the profession by reason of these three principal advantages.

A general uplifting of the tone and character of the profession by reason of its recognized disciplinary organization.

[Extracts from an interesting paper which Mr. Howes recently read before Quantity Surveyors' Association.]

MAINTENANCE OF SHEET ASPHALT PAVEMENTS.*

By Francis P. Smith, C.E.†

The proper maintenance of an asphalt pavement involves the making of such repairs to it from time to time as are necessary in order that it may continue to render efficient service as a safe and smooth roadway or street.

The deterioration which eventually renders these repairs necessary commences as soon as the pavement is laid and may be broadly classified under the following heads:—

1. Defects due to the wear and tear of traffic.
2. Defects caused by the deterioration, through age and exposure of the bituminous cementing material used.
3. Defects in construction.

Traffic Deterioration.—Under traffic the surface of the pavement is abraded and gradually wears off and the mineral particles exposed on the top are more or less crushed and broken. Where these particles are large, this crushing action is plainly noticeable, but with the smaller particles of sand it is hard to detect it. Under heavy traffic and unfavorable weather conditions, these crushed grains become active centres of disintegration. The crushed particles are not bound together by the asphalt cement and are soon swept away. The holes thus made in the pavement serve to retain the moisture and the edges of the holes are eventually more or less broken down, thus enlarging the hole. This condition reproduced all over the surface tends to make it wear away much more rapidly than would otherwise be the case. The effect of this action, which at first glance appears trival, has been so well established by years of investigation and experience that it has become axiomatic in the paving industry that the heavier the traffic the finer must be the particles composing the mineral aggregate. In hot weather, when the pavement is plastic, the abrasion of the surface is much less than in cold weather, when the pavement is hard and possesses practically no plasticity. In hot weather the caulks on horses' shoes sometimes mark up the pavement to a very considerable extent, but the subsequent action of vehicular traffic wears these marks out almost completely. Nevertheless, in a community unaccustomed to sheet asphalt pavements, the appearance of these caulk marks in a new pavement is always regarded as an ominous sign presaging its speedy destruction and failure. As a matter of fact, if the pavement, especially when newly laid, were not soft enough to show these marks it would be an almost infallible sign that the asphalt cement used in it was too hard and that the total life of the pavement would be less than if a softer asphalt cement had been used. Traffic on a pavement always compresses it and increases its density, and for this reason a two-year-old pavement will always mark up less than a new one. The pressure per square inch exerted by the comparatively narrow tire of a heavily loaded vehicle is much greater than that exerted by the heaviest steam roller used in the laying of sheet asphalt pavements. Even if this were not the case, the kneading action produced by narrow tires passing many times over the surface would always give greater compression than could be obtained by the action of the broad tires of a steam roller.

When the traffic is confined to a comparatively narrow space and is always in the same direction, a distinct pushing force is exerted on the pavement. Whenever the pavement lacks inherent stability, due to an improper mineral aggregate or bitumen which is lacking in cementing value from natural causes or the rotting action of gas or water, or a combination of these defects, very distinct waves or bumps will be produced by the action of heavy traffic. These waves sometimes occur in recently laid pavements in which the asphalt cement used was of the highest quality, but in such cases will usually be confined to a few places. Investigation will almost always show defective binder in these spots, or too soft an asphalt cement, or too great a thickness of pavement owing to an error in the grade of the concrete. A paving mixture, designed to have proper stability when laid two inches thick, will often fail in this respect when laid four inches thick, which is the explanation in the case last cited. Too soft an asphalt cement will also reduce the stability of a pavement. Once these waves appear, they are aggravated by traffic passing over them. The wheel of each vehicle rises to the crest of the wave and then drops down with considerable force into the adjacent depression. The plastic pavement in this way is continually displaced at the low spots and shoved up at the high spots until in many instances the concrete will be exposed at the bottom of the depression. Similar depressions are produced by setting manholes too high above the surrounding pavement. Vehicles drop off these high manhole covers onto the pavement and soon pound it out of place. It is better to set all manholes slightly below the grade established for the finished pavement.

Waves are much less liable to appear in those portions of the pavement which are subjected to cross traffic; i.e., in which the traffic does not always move in the same direction. This is usually the case at street intersections, and, if properly constructed, the pavement in these locations almost always lasts longer than in any other part of the street. It has been seriously suggested that in order to increase the effective life of pavements, the direction of the traffic in the afternoon should be the reverse of that in the morning, but the resulting confusion would probably more than offset the gain from such a procedure. Car tracks in a street paved with sheet asphalt may cause the pavement to deteriorate very rapidly. Unless the rails are very heavy and laid on an adequate foundation, they will vibrate excessively when cars pass over them. This is especially the case where tracks designed for light city or town cars are subsequently called upon to carry heavier cars or cars of the interurban type. Not only will the vibration be excessive, but the rails will frequently sink below the level of the pavement and leave depressions where the water will collect. To prevent the vibration from being communicated directly to the sheet asphalt, rows of paving blocks or bricks are frequently placed along the rails, although in many cases the sheet asphalt is brought up directly to the rails. When the vibration is excessive, the sheet asphalt pavement crumbles or cracks in a very short time and leaves an opening for surface water to enter between the wearing surface and the concrete foundation, thus permitting the rotting action elsewhere described to take place.

Effect of Ageing and Exposure.—All bituminous materials used in paving work deteriorate upon exposure to the elements and to the rotting action of escaping gas, water and street liquids. The lighter oils contained in them gradually volatilize, thus hardening the remaining bitumen. As the hardening process goes on, the pavement loses its plasticity and wears away with increased rapidity. Eventually the bitumen loses its elasticity and the pavement cracks. The edges of these cracks crumble away and the cracks become sufficiently wide to be plainly felt by vehicles passing over them. The bumping action previously described in connection with waviness is produced and adds to the

* Abstract of lecture delivered at Columbia University.

† Chemical Engineer, New York City.

rapidity with which crumbling takes place. In order to guard against this and prolong the effective life of the pavement, the asphalt cement used in its construction is made as soft as possible without rendering the pavement too mushy when new. The extent to which this can be carried depends upon the grading and character of the sand employed. With a well-graded sharp sand and plenty of filler, a much softer asphalt cement can be used than with a poorly graded or rounded sand. This is due to the greater inherent stability of the former type of sand. It is obvious that a mineral aggregate which when dry strongly resists displacement will permit the use of a comparatively soft asphalt cement. Modern traffic conditions have in this particular respect come to the aid of the pavement makers. Automobiles in their passage over the pavement are continually dropping a certain amount of oil on its surface which is very evenly distributed by the large number of vehicles passing over it. This oil is gradually absorbed by the pavement and thus softens the bitumen and counteracts to a large extent the hardening action of time upon it. This is very clearly shown in a certain pavement in Chicago, which, prior to the passage of any considerable number of automobiles over it, some five years ago was so hard and badly cracked as to have practically reached its limit of usefulness. The street in question subsequently developed into an automobile centre with the result that the pavement was softened up by the dropping of oil upon it to such an extent that it is still giving satisfactory service. Fifth Avenue, New York City, is a somewhat similar case.

Some asphalts are more easily rotted by water action than are others. With such asphalts it is more than ever necessary to make the pavement as dense as possible to prevent the water from getting into it. Generally speaking, with all asphalts the wetter the climatic or other conditions, the denser and richer in bitumen should the mixture be made.

The action of water upon a pavement may take place from the surface downward or from the bottom upward. The latter action is the more serious and the harder to guard against. The top surface is always compressed to its maximum density by the action of traffic, and if it has sufficient crown and grade to let the water run off and is kept clean so that it will not be covered by a layer of wet mud for long periods, but little deterioration will take place. Where water is allowed to remain in the gutters, the rotting will frequently be very rapid and this will be still more marked if, as in some towns, the dirty wash water from houses is discharged into the gutters. Too frequent washing of a pavement with water at a high pressure is also bad, as the abrasive action of such a jet is very considerable and acts in the same way as the stream from a hydraulic nozzle. In a number of cases water finds its way between the wearing surface of the pavement and the concrete foundation. This may be due to the geological formation of the subsoil strata (and it must be remembered that concrete is not waterproof, especially the type used for foundation work) or the water works its way down between car tracks and the abutting pavement, or through faulty gutter construction, etc. Under such conditions, it has little or no chance to evaporate or drain off and attacks the pavement at its weakest point, i.e., where the compression is the least. It gradually destroys the life of the bitumen and renders it incapable of cementing the grains of sand together. This action progresses upward through the pavement and in some cases is not apparent until only a top shell of good pavement remains. Depending upon the conditions, this action usually manifests itself by a shoving and waviness of the pavement at the point where the rotting has taken place. Owing to the loss of the cementing power of the bitumen, the stability of the pavement has been lowered so that it can no longer withstand the shoving action of traffic previously described. If the pavement is cut through at this point, the white sand grains will be plainly apparent and the whole mass can be readily disintegrated between the fingers. As soon as the rotting action reaches the surface, the pavement is quickly worn away by traffic and a hole is produced.

Gas leaks produce a very similar result and the gas sometimes travels a long distance from the point of leakage before it actually comes in contact with the pavement.

Another cause for the deterioration of sheet asphalt pavement is lack of traffic. Pavements laid on outlying residence streets and culs-de-sac with little or no traffic, crack much more quickly than if they were subjected to a moderate traffic, which appears to be necessary to keep the life in the pavement. This is probably due to the fact that the surface is not in such cases kept at the maximum density by the action of traffic and gradually becomes porous, thus facilitating the evaporation of the lighter oils and also to the fact that the kneading action of traffic, like the continual use of a rubber band, tends to keep the life, so to speak, in the bitumen, and equalizes the stresses set up by contraction and expansion.

Defects in Construction.—These may perhaps be more clearly understood by a general discussion of the principles involved and the correct way of carrying them out and coincidentally calling attention to the particular defects arising from marked departures from standard practice.

Unless the foundation is rigid and of sufficient strength to carry the weight of the traffic passing over the finished pavement, no sheet asphalt wearing surface will give satisfactory service. Being plastic at all normal temperatures, the wearing surface will not bridge over any depressions formed by the sinking or failure of the foundation, but will sink with it. The principles governing good foundation work and design need not be considered here except to say that the sub-grade must be well rolled and compacted in the first place and that good concrete of sufficient strength and thickness should then be put in place and allowed to set before any binder or wearing surface is put upon it. Assuming that the sub-grade has been properly rolled and that the concrete is of the proper thickness and quality, the first point of importance is to see that it is laid to grade. If it is too high in places, the thickness of the binder and wearing surface must be reduced in order that the surface of the finished pavement may conform to the established grade. Any marked diminution in the thickness of the wearing surface will, under heavy traffic, considerably reduce the life of the pavement. On the other hand, if the concrete is laid too low, the thickness of the binder and wearing surface will have to be increased. Within limits, this is not objectionable if the increased thickness is not carried to such an extent as to affect the stability of the pavement, otherwise it will tend to roll and push out of shape under traffic, as previously described. It is usually considered better practice to leave the surface of the finished concrete somewhat rough in order that the binder may key into these depressions and still further resist the shoving action of traffic. After the concrete has been put in place, ample time should be allowed for setting, and this will vary with the weather conditions. Concrete laid in freezing weather will apparently set up when in reality it has frozen. When the hot binder and surface mixture are placed on frozen concrete, the latter is thawed by the action of the heat and becomes mushy and has not sufficient strength to support the weight of the steam roller. Under such circumstances it is impossible to properly compress the hot mixture. In addition to this, the water set free by the thawing of the concrete is forced into

the mass of hot material and more or less of it remains entrained in the mass.

In most forms of construction, a binder is laid directly on top of the concrete, although this is sometimes omitted and a paint consisting of asphalt dissolved in naphtha is applied directly to the dry surface of the concrete and the wearing mixture laid directly on this. It goes without saying that the surface of the concrete should be dry and swept clean before the binder is laid upon it. The binder consists of a mixture of broken stone, preferably the run of the crusher with all particles smaller than 1/10 of an inch in diameter excluded and usually not exceeding 1½ inches in its largest dimension, mixed with sufficient asphalt cement to firmly bind the particles together. Sometimes sand or gravel is added to this mixture to increase its density. Where stone chiefly of the larger sizes is used without the addition of any sand or gravel, it is termed an open binder. The denser mixture produced by the use of better graded stone and the addition of sand or gravel is called close binder. The best modern practice calls for the use of the tight binder as it gives a much firmer foundation for the wearing surface and will not be broken up and loosened from the concrete by the passage over it of the teams hauling the hot surface mixture. The stone should be hard and clean; i.e., free from fine adhering particles of dust or dirt, in order that the asphalt cement may firmly adhere to it and the mineral aggregate must be heated to the proper temperature before mixing it with the hot asphalt cement. Stone which is too cold or damp will not coat properly in the mixer and binder which is too cold can not be given sufficient compression upon the street. If the stone is too hot, it will burn the asphalt cement and harden it so that the binder will be brittle and difficult to compress. Sufficient asphalt cement should be added to thoroughly coat each particle of the mineral aggregate and make a mass which, when rolled, will be sufficiently sticky to adhere to the concrete satisfactorily.

A close binder properly made and laid will be superior in many respects to the mixtures which have been laid on a large number of country highways and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily—sometimes it can be kicked up, and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and, as previously mentioned, binder which is too cold or made with too hard an asphalt cement or an insufficient quantity of asphalt cement can not be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off the stone and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain, the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement which will be displaced by traffic and eventually produce a hole or depression in the pavement. They should, therefore, be cut out and replaced with normal binder.

Before laying the surface mixture on the finished binder course, the latter should be dry and swept clean of dirt; otherwise the layer of wearing surface will not adhere properly to it. The principles governing the manufacture of a suitable surface mixture are similar to those involved in the binder course, except that owing to the heavier duty which it is called upon to perform they are carried further. The particles of the mineral aggregate must be sufficiently hard and fine to carry the traffic without being fractured. They must be of such a character that the asphalt cement will firmly adhere to them and they must be so graded in size as to produce a pavement of sufficient stability and density for the purpose intended. The asphalt cement must be of the proper consistency and the heating and mixing must be so conducted as to produce the best possible mixture. When delivered upon the street, the mixture should be of such a temperature that it can be properly compressed and should be evenly spread by means of hot iron rakes. In many cases the loads of hot surface mixture are dumped directly upon the spot over which they are to be spread. This is bad practice, as the men trample upon it while shovelling and raking it and the rakes do not thoroughly loosen up this trampled material when passing over and through it. Although the mixture is raked to a uniform surface and apparently even thickness before it is rolled, those portions which have been trampled on before and during raking are really covered with a greater quantity of surface mixture than those portions which have not been trampled on and which are covered wholly with what might be termed loose or fluffy mixture. When the roller has completed its work there will, therefore, be a slight unevenness in the finished surface. Under light traffic this would make no appreciable difference, but under very heavy traffic the slight pounding action resulting from this condition would be detrimental and lead to uneven wear of the pavement. Proper and thorough compression of the finished mixture is very essential as this produces a pavement which in its earliest stages is fit to sustain the heaviest traffic. It is always questionable whether portions which are very lacking in compression will be ground out or eventually consolidated. Under unfavorable conditions the chances are strongly in favor of their being ground out. In those portions of the pavement which are inaccessible to the roller, compression is effected by the use of hot smoothers or tampers, or both. If properly handled, the desired results will be obtained, but if used too hot, they will burn the pavement and cause it to scale or grind out. Hot smoothers particularly are dangerous tools to put in the hands of incompetent or careless workmen.

Extreme care should be taken to insure a proper union between the surface laid on successive days. The first loads laid in the morning at the termination of the previous day's work should be a little hotter than normal so that the hot mixture may soften the cold edge of the pavement and bond perfectly to it. The joint should be bevelled and freshly cut away unless the rope joint or a similar method is employed.

The practice of painting the edge of the joint with hot asphalt cement is not to be recommended, as, unless extreme care is exercised, too much asphalt cement will be used and that portion of the pavement will be too rich in bitumen and consequently softer than the rest, which will result in uneven wear and possibly shoving. Great care should be taken not to have any hump or depression when the joint is made. A brief summary of the chief defects and failures met with in practice and the contributing causes is given below.

Cracking.—Cracking of the concrete base—Hardening of the asphalt cement through age—Use of too hard an asphalt cement—Use of an unsuitable asphalt cement—Too

little bitumen in the surface mixture—Insufficient compression—Lack of traffic—Improperly constructed joints—Extreme and sudden changes in temperature—Vibration of street car rails.

Disintegration of Surface.—Defective base—Unsuitable mineral aggregate—Insufficient bitumen in mixture—Insufficient compression—Use of too hard an asphalt cement—Use of overheated mixture—Burning due to use of excessively hot smoothers—Action of water—Action of illuminating gas.

Waviness.—Use of an unsuitable sand—Use of too soft an asphalt cement—Unstable binder—Lack of stability in mixture—Too great a thickness of mixture—Projecting manholes—Action of water—Action of illuminating gas—Uneven raking—Too much bitumen in mixture—Excessively heavy traffic in one direction over a limited area.

Scaling.—Too coarse a mineral aggregate—Too hard an asphalt cement—Action of water—Accumulation of mud—Too little bitumen—Excessively heavy traffic.

Repairing.—This should be carried on within a reasonable time after defects first make their appearance. If this is neglected, deterioration proceeds much more rapidly than would otherwise be the case. Holes and depressions are increased in size by the passage of vehicles over them and water accumulates in them, accelerating disintegration.

Two distinct methods of repairing are in general use: 1, The pavement is cut out and removed down to the concrete and replaced with new binder and surface.

2, The upper portion of the surface is first heated by suitable appliances and a thin layer of it removed by rakes and shovels. Immediately thereafter and while the remaining pavement is still warm, a comparatively thin layer of new hot surface mixture is spread over it and raked and compressed in the usual manner followed in the construction of new pavements.

The first method is so simple that but little description of it would appear to be necessary. The defective pavement is cut up into pieces sufficiently small to facilitate its removal and pried up with crowbars if necessary. The adjacent edges of the old pavement are trimmed up with an asphalt cutter and sparingly painted with hot asphalt cement to insure a proper bond between the old and new portions. Under favorable conditions and when the pavement being repaired is not too old and hard, this painting with asphalt cement may well be omitted. All loose debris is removed down to the concrete and a new binder course and wearing surface is then laid in exactly the same manner as when constructing a new pavement. This method should always be employed in filling up holes and depressions or wherever the defective pavement is in such shape as to necessitate its complete removal, as in the case of rotting from the bottom upward and waviness, defective binder or foundation, etc.

The second, or surface heater method of repair, is conducted as follows: The surface heater is placed over the defective pavement and put in operation. Superheated steam, hot air or flame is then brought in contact with the surface and is allowed to remain there until the pavement has been softened to the required depth, usually from ¾ to 1 inch. The heater is then withdrawn and placed on the next spot to be repaired and the burned material completely removed. The space thus left is immediately filled with new hot surface mixture which is spread, raked and finished in the usual manner. Care must be taken to completely remove all burnt material down to such a depth that the new surface after compression will be not less than ¾ inch in thickness except in a very limited number of cases. Skin patching of less depth than this has not proven satisfactory. In order that repairs made by this method will give satisfactory service, it is essential that the remainder of the old pavement which serves as a foundation should be sound and in good condition and free from water rotting. It is not applicable to the class of repairs rendered necessary by defective binder, or foundation, or water, or gas rotting. When it becomes necessary to re-surface, wholly or in part, a pavement which has become too hard through age to give satisfactory service, the surface heater method gives very good results and is much cheaper than a complete removal of the old pavement down to the concrete. By applying the hot new surface mixture to the remaining portion of the old pavement while the latter is still hot from the action of the heater, a satisfactory union between the old and new work can readily be obtained, provided that the hardening of the old pavement has not been allowed to proceed so far that it is impossible to soften it by the application of heat. Cracks may in most cases be more successfully repaired by this method than is possible in any other way. The repairing of cracks satisfactorily is a very difficult matter. If they are cut out and new material put in, this results in the formation of two joints approximately parallel to the original crack. If the pavement being repaired is old and hard, it is difficult to establish a good bond between the old and new portions, and unless this is accomplished, two cracks will shortly appear where only one existed before. This is especially the case where long cracks make their appearance at considerable intervals and in many instances these had better be left until they become sufficiently wide or numerous to render more or less extensive re-surfacing necessary at these places where they occur.

ROAD WORK IN SASKATCHEWAN FOR 1913.

In preparation for the large programme of work in the construction and improvement of public highways in the province for this year, for which $1,200,000 was voted at the last session of the Legislature, the Board of Highway Commissioners is sending out to all the municipalities in the province a copy of the regulations of the Board regarding assistance to municipalities on highway improvement, together with several blank application forms for use of the municipal councils in applying for assistance.

In those places where an improvement can be definitely described in some form or specifications so that a definite standard to work to can be set and a reasonable agreement made between a contractor and the authorities, so that each party will know definitely what is required, the contract system is the best. Most of the work of road improvement will not conform to these conditions, however, and in such cases gangs under a properly qualified and reliable overseer or foreman is the most satisfactory organization.

The worst of all systems is where councillors order out taxpayers to work out their taxes on the road with no proper provision nor systematic selection of roads that should be improved, and with no attempt made to finish the work started if the taxes run out before this is accomplished.

The Board will be much encouraged to grant large amounts of assistance where the organization approaches the best system. Where municipalities are not organized or properly equipped to economically or satisfactorily carry out road improvement the Board would rather undertake the expenditure of what funds they have available in such municipalities through their own organization.

DUCTILITY TESTS OF RAIL STEEL AND SEGREGATION OF STEEL INGOTS.

The following is an abstract of a paper recently read before the annual meeting of the American Institute of Mining Engineers by P. H. Dudley on the "Piping and Segregation of Steel Ingots and Ductility Tests of Rail Steel."

Bessemer steel of 0.10 to 0.15 per cent. of carbon, for splice-bars, spikes and tie-plates, rises in setting and is cast in bottle-mouthed moulds, which must be capped to prevent an overflow from the top. This grade of steel rises in the moulds and makes a longer ingot than the volume of molten steel when first teemed. The ingots, when allowed to cool and then cut open, show, particularly in the upper part, large occluded blowholes, which, when they are not oxidized or do not contain foreign matter, weld more or less completely if the steel is rolled or forged at about 1,100 degs. C.; and it is in this way that the blowholes are closed in the low-carbon steels.

Boiler-plate and fire-box steel often contains more or less minute laminations, which are the remains of small blowholes forming after the setting metal has reached a pasty condition. The blowholes in the low-carbon steels have not been prevented by using deoxidizers, though the ingots are slightly improved so far as the soundness of the steel is concerned. This grade of steel also rises in the moulds in setting.

Ingots of rail steel containing 0.50 to 0.75 per cent. of carbon are of entirely different character when they are sufficiently deoxidized to form comparatively pure steel, as a well-defined shrinkage cavity forms. This important fact should be remembered in discussing rail-steel, for the greater the degree of its deoxidation, the larger will be the difference between the enclosed volume of hot fluid metal in the mould and the cooler or solidified metal, and proportionately still less will be the volume, should the ingot be allowed to become cold before equalizing the heat and rolling. We must deal with three conditions or stages of the steel:—(1) The greater volume of hot molten metal. (2) The less volume of hot set metal. (3) The least volume of cold metal in the dimensions of the rail sections.

The exterior blowholes in the outside walls of the ingots can be prevented from forming by sufficient deoxidizers, as silicon, ferro-titanium, or compounds of these, and aluminum. The last has been extensively used, but all of its oxidation products do not always escape from the metal, and it should not be used when the steel is to be subjected to the present heavy steel wheel-loads. The silicon content for rail steel now ranges from 0.10 to 0.20 per cent., to make it sound and prevent small blowholes from forming in the setting metal. When sufficient deoxidizers are used to efficiently purify the steel, then, as must be expected, a small cavity starts to form in the top under the cap of the ingot in the setting steel, as already described, and its development should be retarded by stripping the ingot and promptly charging it into the reheating furnace.

Rail ingots are no longer allowed to become cold before being charged into the reheating furnaces for blooming. The size and length of the ingots must be taken into consideration, for in those ingots of which the length is from four to five times the width of the base, the steel will set on the interior walls long before their vertical shrinkage of hot to cold metal has occurred, and this increased length will add proportionately to the volume of the interior piping or shrinkage cavity.

Ingot Size in Relation to Rail Sizes.—It was customary a few years ago to teem ingots which were only 18 by 20 or 19 in. square, and roll four lengths of 100-lb. 33-ft. rails. The height compared to the base was so great that before any shrinkage occurred in the vertical hot ingot walls, the interior shrinking cavities developed so large they could not be prevented entirely from forming, even by prompt charging of the ingots, after stripping, into the reheating furnaces to equalize the heat for rolling.

The 33-ft. 100-lb. rails rolled from four-rail-length ingots of the long type developed in the track a great many split heads and some true pipes, the product from two or three mills being quite pronounced in this respect. Of rails which were rolled during August and September, one purchaser removed in less than six years' service more than 10 per cent. for split heads. The trackmen would report these rails as piped, for the segregated metal in the head would crack under the fillet and admit the air, which would soon discolor the interior surface, and these would be considered as piped rails. There was in some instances a true pipe or shrinkage cavity when rolled, which extended into the centre of the web and well up into the head. The trackmen, however, were not able to distinguish between the true piped rails and the split heads, and it was some time before the latter were attributed to segregation and slag enclosures, which, when recognized, were nearly prevented in subsequent manufacture of rails.

When the mills began to make 33-ft. rails and teemed them into the same ingot moulds which had been used for the 30-ft. rails, and then rolled them in four 33-ft. lengths for 100-lb. rails, a great many ingots were not stripped, weighed and charged into the reheating furnaces with sufficient promptness to prevent a number of piped rails, as the requisite mill practice to check them was not then comprehended under the changed manufacturing conditions.

The segregation was also large, and in 1908, for the New York Central lines, I confined the rolling of Bessemer and open-hearth rails in the United States mills to three 33-ft. rail-length ingots for those of about 19 in. square upon the base. It was also stated in the specifications for the New York Central lines that short, stubby ingots of a length from 2.5 to 3 times the width of the base were required for rails. Ingots of about 8,200 lbs. weight were teemed in moulds 20 by 24 in., and, in good mill practice, will practically complete elimination of piped rails. The blooms, however, were cut, and only rolled in three rail lengths at a time. Ingots 25 by 30 in., of about 12,000 lbs. weight, have been used for eight 33-ft. basic open-hearth 100-lb. rails where the ordinary rail-mill equipment had not been installed. The ingots were bloomed and then shipped to a rail mill to be reheated and rolled, and but a few piped rails were found during manufacture. The rails in the track fulfil the requirements of safety and severe service.

The large mass of metal in the short ingots does not cool quickly, and from the teeming of from 60 to 80-ton melts the ingots would be charged into the reheating furnaces in 1 hr. 30 min., and before all the interior metal had set, with but a trace of a shrinkage cavity started. The distance run by the ingots on their cars from the open-hearth department to the strippers and then to the reheating furnaces aids in consolidating the hot metal in the centre of the moving ingots.

Ingots have been teemed and stripped in the ordinary manner, then taken to the reheating furnaces and when ready for rolling taken out, allowed to cool, and when cut, as would be expected, have shown a shrinkage cavity. The blooms from the companion ingots, when promptly charged into the reheating furnaces and rolled as in proper mill practice, have shown only a small trace of the cavity compared to that in the cold cut ingot.

The specifications for the New York Central Lines require that as soon as the ingots are stripped, they shall be charged into the reheating furnaces to prevent the setting steel cooling from its molten temperature to that of cold metal and to thus avoid the formation of the full shrinkage cavities in the ingots. It has been shown, by the cutting of a large number of blooms, that the shrinkage cavity in the top of the hot ingot is not more than 1/20 to 1/30 of the size of that formed when the ingot is allowed to become completely cold before it is put into the reheating furnace for rolling.

There are only 25 piped rails known to have been found subsequently in service in the track in 65, 70, 75, 80, 95, and 100 lb. sections out of about 1,100,000 30-ft. rails, of which the length of the ingot was not over but under three times the width of the base. The ingots were all stripped by hand in the teeming-pit and charged into horizontal reheating-furnaces, a mill practice long since abandoned. Many 0.06 per cent. phosphorus and 0.60 to 0.65 per cent. carbon rails are still in freight and branch-line service. Some split heads have developed in these rails, due to segregation and the heavy service to which they have been subjected.

Designating Rails by Position of Metal in Ingot.—I was at the mills co-operating in the manufacture and inspection of rails and commenced in 1893 to indicate their position in the ingots by stamping on the web of the top, middle and lower rails the letters A, B, C, respectively. This was for the purpose of studying their subsequent wear and behavior in the track. The A rails contained a larger percentage of oxides, which rose in the steel before completely setting in the ingots, and were faster than the B or C rails under the same traffic. The breakages, however, have been slight in the A, B, or C rails after their many years of service. The ingots were teemed with sharp corners in the moulds, of about 2.5 in. radius, and in the A rails particularly, oxides and slag were entrapped in the corners by the columnar structure of the setting steel. The gauge-side corner of the A rails would show indications of breaking down and spawling to a greater extent under the heavy traffic than the B or C rails. It was possible, after the rails were in the track 8 or 10 years, to identify by casual inspection the A rails from the B or C rails, by the more frequent spawling on the gauge-side corner of the head.

Use of Deoxidizers.—The views of Mr. Benjamin Talbot and Sir Robert Hadfield are old, as to the desirability of completely eliminating blowholes and causing the steel to set sound at the risk of producing a shrinkage-cavity, which must be checked from full development; they have been held and practised by me for the past thirty years in the production of ingots for steel rails. The deoxidizers, apart from the manganese, should be sufficient to cause the steel to set sound without blowholes nearly to the extreme top of the cold ingot. The suggestions of Mr. Talbot and Sir Robert Hadfield, that a large percentage of aluminum be used in the ingots to reduce more completely the oxides, I do not consider advisable. It would be better to use silicon or a combination of silicon and ferro-titanium to secure the desired results. We do not use as high percentages of silicon in steel as is employed abroad, except for tyres.

It is now found for our heavy wheel loads and severe service in the low temperatures of several of the important trunk lines that the high-silicon tyres break more frequently than those in which the content is lower. The suggestion to use from 0.3 to 0.4 per cent. of silicon in rail steel without modification of the other chemical constituents would involve the risk of many rails breaking from the slipping of the drivers upon the rail heads. We must proceed with proper caution in introducing deoxidizers which remain (or whose oxidation products are liable so to do) in the bath of steel. Ferro-titanium, while more expensive than either aluminum or silicon, also acts as a flux, and can be used without danger of leaving its oxidation products in the well-made bath of steel.

Segregation of Basic Open-Hearth Steel Ingots.—The segregation in basic open-hearth ingots for steel rails and wheels has not received requisite attention. I have studied the segregation in several ingots, but do not find it as great in well-purified steel as might be expected with Bessemer metal, which contains two or more times the impurities of phosphorus and sulphur. Well-melted, purified basic open-hearth steel sets quietly and the segregation becomes less in degree.

The Illinois Steel Company, at Gary, when rolling rails for the New York Central Lines in 1912, at my request charged an ingot weighing 8,100 lbs. into the reheating furnace as in ordinary mill practice. In about 2.5 hours, when in condition to roll, it was set outside the furnace to cool. The ingot was 20 by 24 in. on the base and poured 73 in. long. A shrinkage cavity in the cold cut ingot was fully developed from hot to cold steel, and was more than twenty times larger than in the bloom crop of the rolled companion ingot as charged in the usual mill practice. Charging the ingot 10 or 15 min. earlier would have prevented even as large a shrinkage cavity as found in the bloom crop.

Drop and Exhausted Ductility Tests for Open-Hearth Rails.—The exhausted ductility tests for the purification of the steel were introduced into the specifications for the New York Central Lines in 1910 to secure from the preceding eighteen years' experience with the elongation tests Bessemer rails of sufficient toughness to withstand low temperatures of 20 to 30 degs. below zero. The ductility which is possible for a given composition, size of ingots, section and other points of manufacture, has been practically ascertained, and it is to be seen by the exhausted-ductility tests whether or not it is secured.

It requires but a moment to stamp the crop of the rail with the 6-in. spacing bar of seven points before placing the butt on the supports of the drop-testing machine. The elongation of each of the six marked inches on the test butts after the drop is measured by a flexible rule, and the increase in hundredths of an inch per inch indicates the per cent. of elongation. It takes but a moment to test the butt, and the exhausted ductility is obtained in three or more blows through it is measured after each blow and recorded. The lower carbon content of the specification gives one range and the maximum content a higher range, and the mean carbon content is between the two. One of the three can be used as may be necessary in locations for safety, speed and wheel-loads of service.

The term ductility in the specifications for the New York Central Lines is used in the sense of tenacity and toughness of the steel, the exhausted ductility being its measure. This also becomes a soundless test for seams, segregation, slag inclusions and other foreign matter in the web or head of the rails, and is better than the special nick-test in other specifications. The elongation and exhausted-ductility tests are made concurrently with manufacture at the plant under the drop-testing machine on 4 or 5-ft. lengths of the top crop of the rail bars. The butts are tested within 3 hours or less after the ingots of a melt are teemed and rolled, and the facts as to the full ductility of the steel as made and rolled are available for the manufacture of subsequent melts.

Conclusions as to Present Basic Open-Hearth Rail Manufacture.—(1) The chemical composition should provide for

sound steel of ample physical properties of tenacity and toughness rather than hardness combined with brittleness.

(2) The impurities, phosphorus and sulphur, should be in minor amounts, so the bath of metal can be purified to produce the large percentage of toughness and ductility due to the specified chemical composition.

(3) The ingot should have such relations of area of base compared to the height and weight that under good mill practice and with suitable deoxidizers it can be made with controlled segregation and only a trace of a shrinkage cavity in the top; then, when bloomed under its equalized initial heat, it is rendered pipeless by the usual 8 to 10 per cent. discard.

(4) Aluminum can be replaced and silicon partly so, as oxidizers, with advantage by the use of ferro-titanium to purify, solidify and check segregation in rail, tyre and axle steels, and also some of the lower grades of carbon steels where great purity is desired.

(5) The ductility and elongation tests to date furnish the best and only prompt means of determining the degree of purification of the steel per melt as it is made, by indicating the physical properties secured before another melt is tapped from the same furnace, and are of decided advantage to the manufacturer as well as to the consumer. These tests are so advanced that they must be applied with knowledge and understanding for proper results, and not be made mechanically for specified records.

(6) Every process or step of the entire manufacture of the steel and the rolling and finishing of the rails must contribute its part to secure the highest quality of the product incident to the chemical composition.

(7) Specifications should be drawn to indicate some of the major necessities of the consumer, and the tests and inspection should be conducted so as to aid and invite the co-operation of the manufacturers to meet the progressive requirements in rail steel.

OREGON CONSERVATION COMMISSION.

The fourth annual report of the Oregon Conservation Commission shows that unused streams in Oregon are capable of producing 3,300,000 horse-power. These streams are also capable of supplying water to irrigate fully 4,000,000 acres of land, half of which can be irrigated at a cost of $30 to $60 per acre. Of the 686,129 acres of irrigated land in the State, 3.2 per cent. has received water through the United States Reclamation Service, 3.6 per cent. through the Carey Act, 11.3 per cent. through commercial enterprises, and most of the balance through individual or partnership enterprise.

The commission recommends submission to the people of a constitutional amendment providing for a bond issue for co-operation with the United States Geological Survey. It also recommends state construction and control of sufficient power projects to regulate the market and insure cheaper power.

The report contains the complete text of the Water Code of Oregon, with comments on its operation. The law has greatly stimulated investments, and the determination and recording of early rights has progressed rapidly. Twenty-three separate stream systems have already been surveyed, involving about 275,000 acres of irrigated land. Over 2,000 claims to water have been filed with the board, and complete determinations made on fifteen stream systems, affecting 1,018 separate rights and 106,686 acres of irrigated land.

SAFETY FIRST.

A movement which in a short time has attained widespread popularity and been adopted by many prominent railways is that of "Safety First." A paper on this subject was recently read by N. S. Dunlop, claims adjuster, C.P.R., before the Canadian Railway Club, a portion of which we abstract and publish herewith.

The claims adjusters of all the railways in America, who have to follow the investigation of every accident to employees and the public, and finally settle the claims arising therefrom, are credited with originating the "Safety First" plan among railway employees.

They had a strong feeling that if the large number of avoidable accidents and serious injuries to employees were pointed out to them, they would immediately see the necessity for adopting "Safety First" measures for their own personal safety.

According to the report of the United States Interstate Commerce Commission, and the report of the Railway Commission for Canada, for 1911, there were 3,865 employees killed and 130,158 injured—more than 10 employees killed and 3,562 injured every day in the year. A man killed, or injured, about every 24 seconds.

Now, who is paying this appalling toll? Not the public, not the officers, not the clerks. The men who are paying this toll are the men on the firing line in every department of operation, and a close investigation and observation, extending over many years, has shown that from 60 to 90 per cent. of these accidents are preventable, and occur through men taking chances.

The Canadian Pacific Railway adopted the "Safety First" scheme more than a year ago with good results.

Forty-four prominent railways in the United States and Canada have adopted the plan covering 144,329 miles of railway.

On each district committees are formed with a chairman and secretary, and members from every department of operation serve on these committees and hold meetings regularly. The committees are composed of superintendents, agents, engineers, firemen, conductors, trainmen, yardmen, trackmen, freight porters, checkers, roadmasters, sectionmen, etc., etc. Every department has a right to be represented, and every employee of the railway is expected to be a "Safety First" man.

Most of the railways have adopted a "Safety First" button worn by the committee men, and in many cases employees are asking that they be supplied with buttons, to demonstrate their interest in the subject, by wearing it at all times.

If the committee meetings are held during working hours, the committee men are allowed their time and their expenses, if they are away from home.

The investigation of accidents shows that it is the little thing which many people do not bother about that leads up to a serious accident.

Broken boards in freight shed floors, or on passenger platforms, result in broken legs, or ribs. Children are killed, or injured, through allowing them to play on lumber piles and turn tables, and on railway premises. Trackmen are injured by employees throwing ice or empty boxes off moving trains. Brakemen, or yardmen, should never kick over a knuckle, adjust a coupler or angle cock while cars are moving. They may do these things successfully for a long time, but the loss of lives and limbs results too often. These men are chance takers, and the chance taker is the chief supporter of the artificial limb maker and the undertaker.

Employees should always respect the blue flag. The lives and limbs of their fellow employees depend upon it.

Never stand between the rails and attempt to get on an advancing engine or car. If it is necessary to get on either stand outside the rails. Better get on behind.

"Safety First" says emphatically "do not take chances." The time between the prevention of an accident and causing one is only a matter of a few seconds.

Obstruction should not be left near the track for train men to trip over. Drains should be covered at night. Car checkers and others moving about yards should keep from between the rails. They are made for cars and engines to run upon.

The careless, indifferent foreman will have careless men under him, and a greater number of accidents than the man who is always alive to "Safety First."

Look out for loose or missing grab irons, loose brake circles. Do not go under cars without a blue flag to protect you, and see that the car is on its trucks, or so securely blocked up that a change in weather conditions will not tumble it over upon you.

The conductor's highest duty is the protection of his passengers and he should exercise great care in the starting and stopping of his train, and live up to the very spirit and letter of the rule book.

All men engaged in the operation of trains should at all times observe the strictest sobriety, have proper rest, know the rule book by heart, and observe without any quibbling, every rule in the book. They should have no family troubles, and while on duty think of nothing else but duty.

If in doubt, stop. It is better to delay your train than land yourself and your passengers in eternity.

"Safety First" says use torches around your engine and tender, not matches.

Ring your bell before moving your engine off the ash pit.

Do not stand between the apron and the cab when coaling an engine.

Lower your crossing gates in time. Keep clear of passing trains.

Avoid flying stones, or objects falling off a train.

Do not fool with machines—they can be replaced, hands cannot.

Look out for gang planks when loading freight into cars. Do not allow freight handlers to go in their bare feet. They may step on nails and death by lockjaw is sometimes the result.

"Safety First" warns you that it is better to make your slings and scaffolds safe and to use four inch nails instead of 2½ inch nails. It is better to spend five minutes making things safe than to be taken home with a broken back.

Never allow jacks, angle bars or material near the track where they may be struck by a passing train.

When riding hand cars send a man ahead towards a curve, and, if you are likely to be caught and cannot remove the hand car, "Safety First" says: "Let the hand car go and run towards the engine." Hand cars cost $49.40 each. Human lives can never be replaced. Do not carry guns on hand cars and arrange tools so that they will not fall off.

"Safety First" says to men engaged in blasting: "Do not carry a whole box of 100 detonator caps in your pocket. Two or three are sufficient. An explosion means shocking results."

Men should tell their fellow employees of the dangers of their work before an accident happens, and warn them how to avoid it.

Never approve the actions of careless men. Caution them for their own good and for the good of others.

The vast importance of "Safety First" is demonstrated in the words themselves. You may write volumes on these two words, analyze them, describe their objects, explain them any way you like, but you cannot add to the emphasis of that slogan which is bound to reach more railway men, and be of vastly more importance, than any subject they have ever taken up.

On a large number of railways special men have been appointed whose duties are solely to educate the men on "Safety First" habits. This is done by printed literature, lectures, moving pictures showing the right and wrong way of doing work, correcting defective conditions and impressing upon the minds of all classes of employees the danger of taking chances.

In the operation of a railway "Safety First" should be placed above everything else. Unless men are willing to be careful and avoid injury to themselves and their fellow workmen, they should not engage in railway work. A railway does not want careless men in its employ. "Safety First" is always a great convenience, but in an emergency it is an absolute necessity.

The "Safety First" habit must be the creed of every railway man who hopes to succeed in the prevention of preventable accidents.

If whisky or beer interferes with a railway man's work he should give up his work.

Do not ride between crippled cars.

Pile up lumber in yards, drive down grade stakes, fill up holes, turn down boards with nails sticking out of them, and remove anything a train man may fall over.

Do not, under any consideration, go between moving cars.

Do not allow telephone or telegraph wires to hang too low over tracks. Cut them before some poor fellow is knocked off the top of a car and paralyzed for life.

Teach men to be careful. Do not overload engine tanks with coal.

Whenever an employee is killed, or injured, sorrow, suffering, expense, and, if he lives, crippled earning power, is the result.

Do not allow a man with one eye to work where cars are being moved. He cannot see from the blind side.

Do not leave dynamite, torpedoes or fusees where children can play with them, and do not carry them in your pocket.

"Safety First" never sleeps. It says: "Report and have corrected as soon as possible anything which would cause an accident." It calls at all times for suggestions and ideas, from employees, how to save men's lives and limbs.

DISCUSSION ON "SAFETY FIRST."

Prof. Keay: I think the author of this paper is to be congratulated upon having expressed so much logic in so brief a space. The paper is further to be commended for its intimate and human appeal. That it enters a field far wider than that of the railroads alone is evident from a recent request which I have from the assistant manager of one of the largest shipbuilding companies on this continent, for the bibliology of all railway literature available on the "Safety First" movement. This may be regarded as a frank recognition that the railways are the first in the field. It seems to me that the underlying principle of this movement is a practical answer to that old question: "Am I my brother's keeper?"

Mr. A. A. Maver: The subject of this paper is one of great interest to me, and it is also of great and first importance to all employees, not only in railways, but in industrial establishments of all kinds. It is also of interest to employees, and especially since the Employers' Liability Act has come into force, whereby the employer is held responsible, no matter how neglectful or careless the employee may have been in becoming injured. I was at a meeting in connection with "First Aid to the Injured," and one of our officials spoke on the subject of prevention. He said, "You gentlemen here have purposed to care for and give attention to the injured, but the greatest point of all is prevention"—and he brought in the old adage, "An ounce of prevention is worth a pound of cure." Safety first is prevention. I have noticed in connection with our works, and in the casualty reports which come before me, that the higher the intelligence of the employee the less injuries are sustained, but the lower the grade of intelligence the greater the number of injuries. This is particularly true in the case of our foreign labor, which men are generally of a very low order of intelligence. They are handicapped also by not speaking our language, and, in fact, have to be led out of danger by other employees. The great trouble is that their fellow-employees, who have more intelligence, give them credit of having an equal intelligence, and the result is they are often not warned as they should be. Mention is made in this paper of keeping torpedoes out of the hands of children. These torpedoes are used for the protection of trains during fogs or heavy snow storms, when the visual signals cannot be readily seen, the explosion warning the engineer of danger ahead. They are supposed to be removed from the locomotives when they are sent to the shop for repairs, but occasionally one is left on an engine, and it gets into the shop. It is gotten hold of by some inquisitive man, who sees in it an explosive of some kind, and who slyly puts it under a locomotive which may be moving in or out of the shop. As the wheels pass over it an explosion takes place, the metallic casing flies in all directions, and we have had some serious accidents from this cause; but it is always difficult to find out who put the torpedo on the rail. We had a case of one young man who wanted to hear what kind of a report a torpedo would make. He placed one on a piece of metal, got a hammer and struck it. He not only heard the report, but also had a very badly mutilated hand. This is all through ignorance, yet warning notices have been put up. It seems to me a duty on the part of our employees to point out to their fellow-employees where the danger exists. If this is done a great many accidents would be avoided.

CIVIL SERVICE COMMISSION.

Applications will be received by the Civil Service Commission for the following positions: A correspondence clerk in the Forestry Branch of the Department of the Interior, an assistant engineer in ore dressing and metallurgical division of the Mines Branch of the Department of Mines, twelve technical clerks for temporary employment in the Topographical Survey Branch of the Department of the Interior, and a draughtsman in the Forestry Branch with a knowledge of survey work and general drafting.

Application forms, properly filled in, must be filed in the Office of the Civil Service Commission, not later than the 26th May in the case of the first two and the last positions, and not later than the 19th May for the technical clerks in the Topographical Survey. Forms may be obtained from Wm. Foran, the Secretary of the Commission, Ottawa.

COAST TO COAST.

Ottawa, Ont.—Accompanying is a table showing the results of an analysis of the water supply about to be brought from Esquimalt, as determined by City Analyst Birch. At Elk Lake, "A"; Goldstream, "B"; Sooke Lake, "C"; Richardson Street spring, "D"; and Spring Ridge spring, "E":

	Free Ammonia	Albuminoid Ammonia	Chlorine	Volatile Solid	Fixed Solids	Total Solids	Nitrates	Nitrates	Reaction
A	.001	.012	.6	3.2	4.2	7.4	.00	.00	Neutral
B	.001	.003	.5	1.5	2.5	4.0	.00	.00	Neutral
C	.001	.008	.5	2.0	.4	2.4	.00	.00	Neutral
D	.000	.001	1.3	6.0	8.5	14.5	.5	.00	Neutral
E	.000	.003	4.2	12.5	25.0	37.5	.8	.00	Neutral

The first two columns are parts per 100,000, and the others in grains per gallon. From the standpoint of purity the albuminoid ammonia as determined from Wanklyn's process, gives the best idea of the purity or otherwise of the water from contamination, taking in view, of course, the amount of free ammonia and chlorine which would be found in excess in water fouled by excreta. That at Elk Lake is slightly lower than the British standard of 0.015; however, it is safer in this country with a higher percentage than in Britain on account of the less densely settled communities. Therefore, bad as Elk Lake supply has been in summer from the point of odor, it has practically no injurious effects, although last year at one time it was felt desirable for the board of health to issue a warning on the subject to the citizens about boiling it. The two city springs are, of course, remarkably pure.

Toronto, Ont.—The Toronto delegates attending the fifth National Conference on City Planning at Chicago have returned. The party consisted of Aldermen S. Morley Wickett and H. J. Anderson, Geo. Powell, Assistant City Engineer; Chas. E. Chambers, Parks Commissioner; Jas. C. Forman, Assessment Commissioner; Messrs. Dunington-Grubb, J. P. Hynes, and E. L. Riggs, of the Civic Guild, and Miss E. B. Neufeld, of the Central Neighborhood House. At the conference were 230 delegates, representing 53 American cities outside Chicago, and six Canadian cities. These composed the best authorities on the subject in America. A great development of the park and boulevard system is being carried out in Chicago. The parks in the city have been linked together by magnificent boulevards about 150 feet wide, splendidly paved and most efficiently maintained, and marked with a cleanliness which is most striking. In a huge semicircle these driveways surround the city, and the base is formed by Michigan Boulevard. In all, there must be between 50 and 60 miles of continuous roadway. This was one of the most impressive works they had seen, stated Mr. Riggs, and pointed out that as the geographical situation of Toronto was practically the same as that of Chicago, the plan they are carrying out there could easily be adapted to our own city. This plan has been already outlined for Toronto by Parks Commissioner Chambers, who stated: "The boulevard system made us envious. Alderman Anderson and I are going to prepare reports on both these features to be submitted to Council soon, and in the hope that Toronto may do something along the same line." Mr. Chambers said that while nothing was known as yet to the choice for the 1914 convention, Toronto would likely be the convention city. Twenty-five cities sent invitations, but Toronto will get the convention. "If they come here we will

make the association an international one," said the commissioner. "It will be the first town planning congress to be held in Toronto."

Victoria, B.C.—While the effort to obtain national government participation in the highways progress of the United States accumulate force, the various states, one after another, are adopting legislation providing for the establishment of state highway departments. According to information received by the American Automobile Association National Good Roads Board, which keeps in touch with the state automobile bodies and aids materially in their work, there will be, as a result of recent legislative action, road departments in Maine, Montana, Missouri, Colorado, Idaho, Arkansas and Texas. This makes plainly apparent that the move for federal action has not caused any "lying down" on the part of the states, which have their proper part to perform in the general roads development. Of the addresses given at the second federal aid convention in Washington, called by the National Good Roads Board, none contained a more comprehensive summing up of the situation than the remarks of Representative William P. Borland, of Missouri, who, among other things, said: "I believe that the good road question is the biggest question, without exception, now facing the American people. In Congress we are trying earnestly and sincerely to deal with this problem of the extent and character of federal control and federal aid to good roads. There are difficulties confronting us. Some of us believe in a continuous system of roads, roads that go somewhere, roads that give us the benefit of the scientific progress of engineering skill that has been developed in connection with road building. We believe that federal aid, if it comes at all—and it must come—must mean a better type of roads, long roads, roads of higher class, roads of a more permanent character, roads that go somewhere, roads that mean something in the development of the country. But here is the idea that must occur to every thinking man. We do not have to improve the 2,150,000 miles of highways in the United States. That need not stagger any man's imagination. Experience has shown, at the very threshold of this subject, that 90 per cent. of the traffic on roads goes over less than 10 per cent. of the roads. If we had a system of good roads leading fairly into every section of the country, within the reasonable reach of the majority of the citizens and producers and taxpayers of the country, that system would be a vast advantage over the present system of isolated local control of highways. If we can bring that about by a spirit of self-sacrifice and co-operation, and if we can get together on the idea that it is better to have some good roads than it is to have no good roads, then we will all get behind some proposition and accomplish something for good roads, and it is going to take that spirit of co-operation and self-sacrifice to bring about legislation."

Quebec, Que.—That there is little prospect at present of any Government action towards securing the refining in Canada of silver ore which now goes to New York for the final process, but that the Government expects to shortly enlarge the refinery at the Ottawa Mint so that it will be able to take care of the whole gold production of the Dominion, were announcements made in the Commons recently by Hon. W. T. White, Minister of Finance, in the course of a discussion on a bill increasing from $75,000 to $110,000 per annum the vote for operating expenses. Sir Wilfrid Laurier suggested that in view of the fact that practically all the Canadian silver output, amounting last year to $19,000,000, went to New York for refining purposes, the Government should take steps to encourage silver refining in Canada. Mr White, however, said that economic conditions of refining and marketing and considerations of technical processes, made it impracticable at present to change the present refining and marketing and considerations of policy of centring the silver refining industry on the large and costly American plants.

Toronto, Ont.—The supply of iron ore available under present methods of mining in the entire world has been stated by geologists of international reputation at 22,000,000,000 tons, from which it is estimated 10,000,000,000 tons of iron may be produced. At the present rate of consumption, this supply would last the world about sixty years. There are, however, more than 123,000,000,000 tons of ore not now commercially available, which, with improved methods of production, may be made to yield in the future an additional 53,000,000,000 tons of iron, which would run the world along for another 300 years, if no more iron were used annually than at present.

Winnipeg, Man.—The construction of the Canadian Pacific Railway tunnel under the Selkirk Mountains, for which the contract has been let, will be a tremendous undertaking. Owing to the fact that the tunnel work cannot be accelerated because of the impracticability of driving shafts a mile deep through the mountain, work on the tunnel proper will be necessarily confined to two ends. This will make work slower of accomplishment than if, as in the case of the Canadian Northern tunnel under the mountain into Montreal, a shaft could have been sunk near the centre of the tunnel. If this had been practicable, four shifts could have been employed in tunnelling night and day, and work would have been greatly expedited. As it is, only two shifts can be used night and day on the two drilling surfaces. Some difficult engineering feats are being faced in building the approaches, but these pale into insignificance in the presence of the vaster task of piercing the mountains. Besides this, twenty miles of double tracking, which is now being undertaken in connection with tunnelling, the Canadian Pacific is also asking for tenders for forty-nine miles more of double tracking in the mountains. Twenty-five miles of track are to be built east of Kamloops and twenty-four west of Revelstoke.

Montreal, Que.—The Phœnix Bridge and Iron Works Company is making a new issue of bonds and stock this week, through the Quebec Savings and Trust Company. This stock has already been underwritten, and is now being distributed to the public. The offering consists of $750,000 of 6 per cent. first mortgage bonds, and of $800,000 of common stock. The bonds are being offered at 96 per cent of par, and the stock at $50 per share. The offering is being made simultaneously in London and in Canada. Approximately $450,000 of the bonds and $405,000 of the stock have been taken firm. A new company has just been incorporated at Ottawa with a capitalization of $1,500,000. This company in every way takes the place of the company which has heretofore operated under the same title. After the present issue has been accomplished, there will remain in the treasury to provide funds for future expenses and for the general purposes of the company, $700,000 of the common shares of the company. All the bonds will have been issued. The company has a plant situated in the centre of the manufacturing district of Montreal, where shipping facilities are all that could be desired. The concern manufactures and erects structural steel for bridges and buildings. The cost of delivery, owing to the central location of the concern, is smaller than in the case of most other companies. Operations have now been carried on satisfactorily since 1898, and, save for an occasional year, earnings have shown a fairly constant increase, beginning with $51,000 in 1898 and progressing gradually to upwards of $600,000 during the past couple of years. The land owned by the company allows of an expansion to the works. The assets of the company, at the end of last year including $25,000 which is being provided for improvements, amounted to $1,400,00, while total liabilities were but $57,000. This leaves a surplus of $1,243

against the present bond issue of $750,000. Mr. James W. Pyke is president of the company, and Mr. T. Palmer Howard is general manager.

Victoria, B.C.—Plans for harbor improvements progress steadily. This year Victoria will have its large docks under way. These are to be built by Sir John Jackson & Company, and something will be accomplished also in connection with the dredging of False Creek in Vancouver. To give better facilities for shipping, it is announced that the government will establish a drydock at Esquimalt, this being stated as part of the naval scheme on the Pacific. Mayor Baxter, of Vancouver, who was in Vancouver in connection with harbor and other matters, returned on the 1st instant, and reports that it is very probable that a drydock will be built at Vancouver along the lines of some of the schemes proposed heretofore. News of the government grain elevator is also brought back by the mayor. He does not say, however, that this will be erected right in Vancouver, but it will be close enough for this city to reap benefit from the business Along the waterfront of Vancouver there is hardly room for a large grain elevator, since it is a very busy place. Moreover, if an elevator is erected some distance out it will help to give strength to the outlying reaches of Greater Vancouver. With the passage at Ottawa of the bill to incorporate the harbor commissioners of Vancouver, no time should be lost in completing the personnel of this board, so that this legislation may be effectively implemented. It will be found that there will be many matters for a board of this kind to adjust and adjudicate upon, and if trade grows as it has in the past, and as is anticipated, the harbor commissioners will be kept down to steady business.

Montreal, Que.—The Montreal Engineering Company, Limited, of Montreal, has been given a franchise by the Medicine Hat council to build and operate a street railway system. The by-law will be submitted to the burgesses on May 22nd, when it is expected that the agreement will be approved. The franchise is for a twenty-year term, renewable for a further term of five years or more. Construction will commence June 1st and rushed to completion of the first nine miles of track. Power will be supplied by the city as alternating current, or the company will install its own plant, operated by natural gas supplied by the city.

PERSONAL.

C. H. MITCHELL, C.E., has been appointed a member of the Board of Governors of the University of Toronto.

H. GALE LEGG, town engineer of Preston, Ont., has been appointed to a position in the chief architect's office at Ottawa.

WM. C. SAMPLE, consulting engineer of Fort William, Ont., has been called in by the Township of Neebig, to report on a sewage disposal scheme.

MR. E. J. HOLLAND, acting city engineer of Guelph, Ont., has been appointed city engineer. Mr. W. C. Clauson has been appointed assistant city engineer.

MR. A. T. ENLOW has resigned as manager of sales of the Stark Rolling Mill Company, Canton, Ohio, and has become associated with the Pedlar People, Oshawa, Ont.

MR. H. M. KENZIE, at present in the employ of the water power branch of the department of the interior at Ottawa, has been appointed as city commissioner of Prince Albert, Sask.

GEORGE H. BOWEN, B.A.Sc., has opened an office as consulting, mechanical, and electrical engineer at 34 Victoria Street, Toronto. Mr. Bowen graduated from the University of Toronto in 1909, and latterly has been connected with the Niagara Falls Park Commission.

PROF. R. B. MILLER, dean of the U.N.B. Forestry School, has accepted a position with the forestry branch of the Department of Natural Resources of the C.P.R., for the summer to do consulting work similar to that done by Prof. A. H. D. Ross, of Toronto University, in British Columbia.

MR. F. P. GUTELIUS has been appointed general manager of the Government Railways. He is appointed for a two-year term. He will supervise and direct all departments of the Government railways, and will be in charge of the Hudson Bay Railway when completed. The order provides for the abolition of the present Intercolonial Board of Management. Mr. F. P. Gutelius was born in the United States in 1864; he graduated as a civil engineer in 1887, and started to gain experience with the Pennsylvania Co., Pittsburg, Pa. He went to British Columbia in 1895 and was general superintendent of the Columbia and Western Railway (constructing and operating railway between Robson and Rossland) till 1895, when he joined the C.P.R. He successively held positions as division superintendent, in the Engineering Department, as engineer of maintenance of ways, and became assistant chief engineer of eastern lines in 1906, general superintendent of Lake Superior division in 1908, and superintendent of the Eastern division in 1910. Early in 1912 he was appointed by the Government to investigate all expenditures on the National Transcontinental Railway. He will have his headquarters at Moncton, N.B.

PROFESSIONAL DEGREES GRANTED BY UNIVERSITY OF TORONTO.

The following have completed the requirements for professional degrees as laid down by the University of Toronto:—F. A. Dallyn, the degree of civil engineer (C.E.); E. A. James, the degree of civil engineer (C.E.); C. H. Marrs, the degree of civil engineer (C.E.); D. L. H. Forbes, the degree of mining engineer (M.E.); A. G. Christie, the degree of mechanical engineer (M.E.); E. H. Darling, the degree of mechanical engineer (M.E); G. J. Manson, the degree of mechanical engineer (M.E.); R. S. Smart, the degree of mechanical engineer (M.E.); P. H. Mitchell, the degree of electrical engineer (E.E.).

THE AMERICAN INSTITUTE OF CONSULTING ENGINEERS.

A meeting of the Institute for the purpose of discussing "The Incorporation of the Institute," also "The Physical Valuation of the Railroads of the United States as Authorized by Act of Congress, March 1, 1913," will be held at the Engineers' Club, 32 West 40th Street, New York City, Thursday evening, May 22nd, 1913, at 8 p.m.

TECHNOLOGY CLUB OF LOWER CANADA.

The Alumni of the Massachusetts Institute of Technology met last week in Montreal for the purpose of forming an Association to be known as the "Technology Club of Lower Canada."

The club includes among its members this Alumni of the Institute now residing in Eastern Ontario, Province of Quebec and the Ottawa Valley. The following officers were elected:—President, Mr. F. E. Came; vice-president, Mr. H. E. Stearns; secretary-treasurer, Mr. E. B. Evans; board of governors, Mr. D. J. Spence and Mr. R. Heckle.

The club will have two regular meetings each year, as well as a weekly meeting at a local restaurant for the purpose of forming the object of the organization.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The spring meeting will be held this year at Baltimore, Md., May 20th to 23rd, inclusive, at the invitation of the Engineers' Club, of Baltimore, and the local members of the society. The professional sessions have as usual been arranged by the Committee on Meetings, while all other events are in charge of the local committee under the chairmanship of Layton F. Smith, past president of the Engineers' Club, of Baltimore.

Special railroad transportation concessions have been secured for members and guests attending the spring meeting in Baltimore, May 20th to 23rd, 1913.

The special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards in United States territory.

COMING MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Spring Meeting, May 20-23. Secretary's Address 29 West 39th Street, New York.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Keilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, May 22, 1913 Contents of this issue on page 755

The Canadian Engineer

An Engineering Weekly

TEST-LOADING UNTIL BREAKING POINT OF A 100--FOOT ARCH BRIDGE.

By V. J. ELMONT, B.Sc., A.M. Can. Soc C.E.

On account of an exhibition in Düsseldorf, manufacturers interested in the cement industry decided to build a concrete arch bridge on the exhibition ground. It was the intention to let this bridge enter into the future street layout, and it was, therefore, designed for a 25-ton steam roller and 80 pounds per square foot uniformly distributed. Later on, however, circumstances occurred which made it necessary to change the street layout and remove the bridge, as it was of no use in the new scheme. An extraordinarily good opportunity was thereby given to test-load an actual concrete construction to destruction point, and make a very desirable comparison between theoretical and practical results.

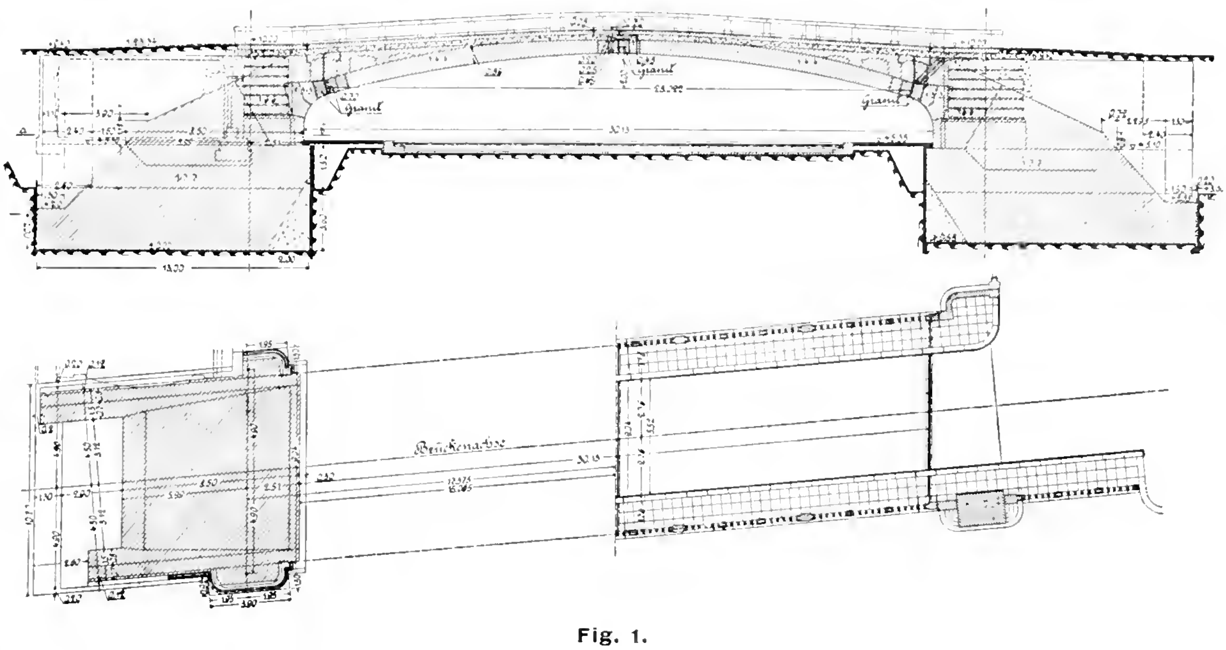


Fig. 1.

The German Concrete Society undertook the planning of the loading and carrying out of the measuring was entrusted to the Government Testing Institute at Berlin.

The span of the bridge was 91.9 feet, the rise 6.6 feet and the width 29.5 feet. There were arranged 3-foot granite hinges with 6.88 and 8.00 feet radius, and the thickness of the arch was 2.8 feet between the hinges. The concrete mixture was 1:4:4. Before loading was commenced a wooden falsework was built up under the bridge, strong enough to bear the bridge and the loading materials when the breaking point was reached. The fill concrete over the arches was removed in order to figure out the stresses due to the test-load as exactly as possible; this concrete, having been a 1:6:6 mix, had become so hard during the six years the bridge was used that it would have influenced the results of the test due to its statical co-operation.

The following measuring apparatus was used in the test:

For determination of the angle-turning of the abutments a level was used on both sides (the bridge was situated close to the Rhine, in the direction north to south) over each of the four abutments.

The vertical and horizontal movements of the abutments were measured by the apparatus shown in Fig. 2. A pin (a) was fastened to the stones with gypsum, and this pin was connected with two wooden arms which, by means of rubber bands, were held in touch to two rolls (2 and 3 in Fig. 2) whose turning could be read off.

The turning of the huge stones was measured by levels on the land side. On the Rhine side pieces of plate were fastened to each hinge, which overlapped each other. For each loading stage a line was drawn in the plate below along the edge of the plate above, and the neutral position of these lines determined the turning angle.

The deflection of the arches was measured on both sides of the bridge and at three points for each arch, and for the whole bridge at 12 points, by the apparatus shown in Fig. 3.

At the crown of the arches common inch scales were used, as greater vertical movements could be expected there.

It being an assumption for the correctness of the measuring that the piles, which carried the apparatus, were standing firmly, an investigation was set on foot to prove it. In a distance of 9 feet from the bridge a pile was driven opposite each of the apparatus. The piles were connected in pairs with timbers carrying levels. These did not show any movement during the loading of the bridge.

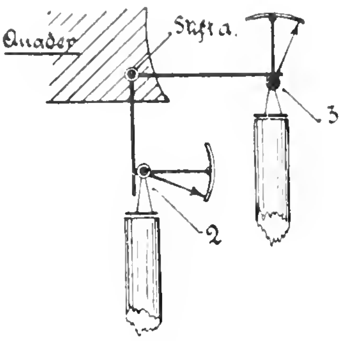


Fig. 2.

To determine the position of the resulting forces in the different sections of the arches and the value of the compression and tension stresses along the intrados and extrados a number of elongation measurements were taken at the centre of the arches by means of Martens mirror apparatus (Fig. 3 a), which give a minimum reading of 1/125,000 of an inch, and at the ends by an index apparatus (Fig. 3 b) which gives a reading of 1/60,000 of an inch. In the Martens apparatus the one end of the measuring spring is supported by a pin (p) put into the arch two inches from the edge, and between the other end and the pin (q) the mirror is placed. A change in the distance between the two pins effects a turning of the mirror to the right or the left, whereupon the variation in the length can be determined by telescope reading in the usual manner. From the elongations the stresses can be figured out directly. For the index apparatus the principle is similar. A lengthening or shortening of the measuring length effects a movement of a cylinder, connected with a long index, whose turning can be read on a scale.

On the Rhine side only were placed apparatus at the centre of the arches, at the top and below. Here was used the Frankel-Leuner's instrument, which had a turn-over ratio of 1/140 only. The alteration in the length is through a lever system carried over to a writing pin, which notes its movement on a paper roll drawn by a clock-work mechanism.

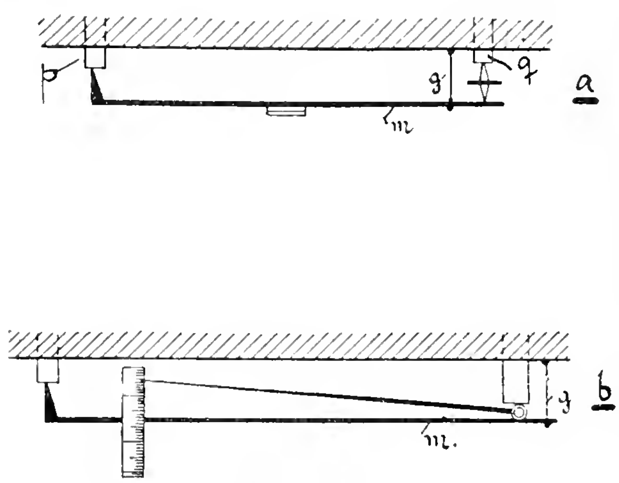
The loading consisted of pieces of steel placed on the southern half of the bridge, over an area 16 feet long and 26 feet wide. It had first been proposed to load the arch from the crown to the springing line, but this plan was given up, owing to the difficulty of procuring a sufficient quantity of steel.

As the weight on the bridge had reached 75 meters, the instruments were read for the first time, and thereafter the reading was continued during the loading. For each loading stage a measurement was taken every fifth minute, until no further alteration in the position could be seen.

The results of the observations are graphically shown in Fig. 4, which gives the alterations in the centre lines of the arch on the land side by loading increases of 75 tons; the curves give the vertical and horizontal movement of the abutment and the vertical movement of the crown, and the centre of the unloaded arch half; the measuring on the land side agreed perfectly with those on the Rhine side.

The increasing load produced first a uniformly increasing deflection at the crown and a curving and raising of the unloaded arch. In Fig. 4a and 4b is shown the movement of the arch axis under a load up to 225 tons. From Table I. it will be seen that this load gives a deflection at the crown at 2.2 of 1/25 inch and a raise in the centre of the unloaded half of the arch of 1.3.

As the test-load was increased to 225 tons a sudden change took place in the direction of the movements, due to a crack which had formed in the arch at the edge of the load. (Fig. 5). The testing institution speaks concerning this crack in the report of the experiments in the following way:—



Figs. 3a and 3b.

An hour before the load 150 tons was reached, as the load of the steel on the bridge was nearly 124 tons, more cracks, which probably did not go very deep into the concrete, were seen at the underside of the loaded part of the arch. A short time after the steel load had reached 140 tons the very fine crack (a, Fig. 5) which could be seen from the start of the experiment, commenced to enlarge, so that it could be seen under the whole bridge, and at last appeared on the Rhine side of the bridge. (Fig. 5).

At all the instruments, however, it was found that the movements of the bridge first started to go in the opposite direction to what had been the case before, when the load was 225 tons. It must, therefore, be assumed that the crack

Table I.

Point.	Movements in 1/25 of an inch. 75 Tons.	150 Tons.	225 Tons.	300 Tons.	400 Tons.
In vertical direction—					
Crown	—1.1	—1.6	—2.2	+0.5	+29.2
Centre of northern arch half	+0.5	+0.7	+1.3	—1.1	+20.0
Northern abutment stone	+0.1	+0.6	+0.7	+1.0	....
Southern abutment stone	+0.1	+0.4	+0.8	+0.7	....
In horizontal direction—					
Northern abutment stone	+0.2	+0.5	+0.7	+0.9	....
Southern abutment stone	—0.1	—0.6	—1.4	—1.5	....

+ Means movement upward or to the right. — Means movement downward or to the left.

occurring first under this action had penetrated so deeply into the concrete that it conld influence the eqnilibrium of the arch. At 300 tons loading the crown had raised 2.7 (of 1/25 inch) over the position it had when loaded with 225 tons (Fig. 4 c), and 0.5 over the original position at the commencement of the experiment. The next 100 tons called forth a further movement upward in this point of 28.7.

Consequent on this movement the unloaded northern arch half (to the right in Fig. 4) which hitherto had been curved strongly, was straightened again so that the centre had raised to 1.1 under the original position when the test-load was 300 tons; afterwards the arch turned upward around the hinge and at 400 tons load the centre was 20.0 over the point where it was situated when the bridge was loaded with its own weight alone.

The angle turnings measured at the levels on the hinge stones agreed with the above-mentioned movements. The crown hinge opened first downward, corresponding to the deflection at the top and toward the finishing of the experiment upward. The sonthern abutment hinge (to the left in Fig. 4), to which the loaded bridge is attached, opened up during the whole experiment, the northern down.

The hinge stone on the northern abutment moved in all, after the agreeing measurement on the land and Rhine side, .9 horizontally and 1.0 upward and turned ¾ backward in a loading from 0 to 300 tons. At the southern abutment a similar movement to respectively 1.5 and 0.7 took place, but the result of the level readings did not agree for this abutment with the mentioned movements. The reason can perhaps be found in the circumstance that this abutment had not been separated from the walls of a building standing close by, as the leading persons thought that it was better to save the expense of that work, as no importance was attached to the behavior of the abntments during the test-loading. As a very great number of instruments (in all 41) were used, it was possible, in spite of the many different disturbances

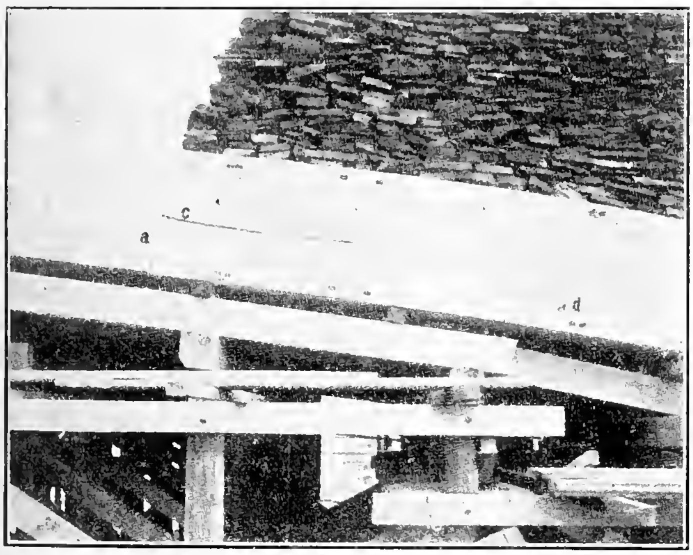


Fig. 5.

arising from changes of temperature, wind, etc., for each kind of measuring to find a sufficient number of agreeing apparatus, the reading of which could be used for comparing with the theoretical researches.

These results all aided in a determination of the pressure lines for the different loading stages. (Fig. 6). As the weight of the load and its position on the bridge were exactly measured and the specific gravity of the concrete in the arch had been found to be 2.36, the acting forces were fully known, both in regard to value and situation, and it was thns possible for each stage to draw an exactly determined pressure line, also the acting points of the pressures in the hinges had been measured. As the figure shows, the pressure line rises more and more under the loading by an increasing of the load from 0 to 225 tons, until, under influence of this load it reached the extrados of the arch. At

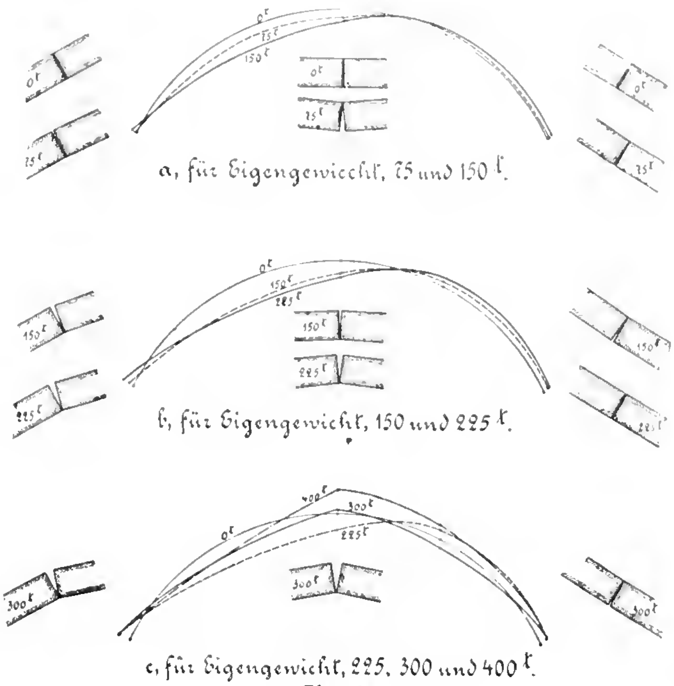


Fig. 4.

the intrados, rises corresponding to this position of the pressure line an increasing tension stress was shown. In the unloaded part of the arch the pressure line becomes more and more flat with corresponding tension at the extrados.

From Fig. 6 it will be seen that the distance of the pressure line from the centre line of the arch is essentially greater in the loaded side than in the unloaded, and greatest under that half of the steel load which is nearest to the crown; therefore, the greatest bending stress occurs here and at the same time considerable shear stresses, as the direction of the pressure line deviates so much from the centre line. The greatest unfavorable concentrated load produced such tension and shear stresses in the arch that it is not to be wondered that a poured joint, which otherwise was fully excluded from the bridge, and which accidentally was situated at the edge of the loading material, opened. The crack commenced at the intrados and was then transmitted upward into the arch and, as the statical examination shows, the crack was throughout so deep that the tension stress in the remaining concrete was 350 to 400 lbs. per square inch. When the length of the crack was equal to half of the arch thickness on the Rhine side and ¾ on the land side (300 tons load) a horizontal shear crack was visible. (Fig. 5). It was now assumed that the bridge would collapse, the thickness of the undamaged concrete being only 16 inches on one side and 8 inches on the other; but no break took place, and it was possible to increase the load by one-third up to 423 tons.

Between 225 and 300 tons the vertical crack came into full action, which can be seen from the fact that the extensometer, which was placed in the point d (Fig. 5) in the neighborhood of the crack, was suddenly unloaded, having hitherto shown increasing tension stresses. At the same time the

agreeing reading on the four deflection meters at the crown of the arch showed that this point commenced to raise. This means that the loaded part of the arch tried to straighten, and corresponding to this a considerable rolling must have taken place in the crown hinge. This was also clearly visible by the levels. By this turning the pressure was moved downward, by which a new pressure line could be figured inside the undamaged concrete and which would explain the new

Table II.

Moduli of elasticity (E), stresses (ζ), and length alterations per unit (λ). E and ζ in lbs. per square inch, λ in 1/100,000 of the measure length.

A.—Measuring on the bridge.			B.—Measuring on the cubes.					
			Cube No. 1.			Cube No. 2.		
ζ	λ	E	ζ	λ	E	ζ	λ	E
Tension.								
330	65.0	5,050,000	.....	.....	....	.....	.....	....
231	52.0	4,440,000	.....	.....	....	.....	.....	....
168	34.0	4,900,000	.....	.....	....	.....	.....	....
70	18.0	3,920,000	.....	.....	....	.....	.....	....
14	0.5	2,800,000	.....	.....	....	.....	.....	....
Compression.								
24	6.0	3,910,000	.....	.....	....	.....	.....	....
70	18.0	3,910,000	.....	.....	....	.....	.....	....
129	21.0	5,600,000	.....	.....	....	.....	.....	....
154	28.0	5,450,000	.....	.....	....	.....	.....	....
256	67.0	3,920,000	.....	.....	....	.....	.....	....
...	....	....	270	47.0	5,740,000	.....	.....	....
...	....	....	....	.....	....	272	42.3	6,450,000
336	54.0	6,150,000	.....	.....	....	.....	.....	....
342	90.0	3,780,000	.....	.....	....	.....	.....	....
...	....	....	448	80.3	5,600,000	.....	.....	....
...	....	....	....	.....	....	445	82.9	5,480,000
484	113.0	4,340,000	.....	.....	....	.....	.....	....
532	107.0	4,900,000	.....	.....	....	.....	.....	....
...	....	....	630	116.0	5,430,000	.....	.....	....
...	....	....	....	.....	....	636	128.2	4,960,000
706	160.0	4,440,000	.....	.....	....	.....	.....	....
748	146.0	5,040,000	.....	.....	....	.....	.....	....
...	....	....	809	154.0	5,250,000	.....	.....	....
...	....	....	....	.....	....	817	170.2	4,800,000
...	....	....	990	189.0	5,230,000	.....	.....	....
...	....	....	....	.....	....	1,000	217.5	4,590,000
...	....	....	1,170	228.0	5,120,000	.....	.....	....
...	....	....	....	.....	....	1,180	254.1	4,640,000
...	....	....	1,350	263.0	5,120,000	.....	.....	....
...	....	....	....	.....	....	1,360	292.1	4,650,000
...	....	....	1,520	305.0	4,980,000	.....	.....	....
...	....	....	....	.....	....	1,540	334.0	4,600,000
...	....	....	1,710	342.0	4,980,000	.....	.....	....
...	....	....	....	.....	....	1,720	377.3	4,560,000
...	....	....	1,890	382.0	4,940,000	.....	.....	....
...	....	....	....	.....	....	1,900	419.3	4,540,000
...	....	....	2,070	423.0	4,900,000	.....	.....	....
...	....	....	....	.....	....	2,080	475.5	4,480,000

Table III.

The elongations λ measured on 3.28 feet = 1 meter one-quarter of the span from the springing line in 1/25,000 inch. + Means elongation. — Means shortening. e Means extrados. i Means intrados.

	75 Tons.		150 Tons.		225 Tons.		300 Tons.	
	e	i	e	i	e	i	e	i
(a) Loaded part of arch	—54	+ 2	—107	+ 34	—146	+ 65	—213	+ 50
(b) Unloaded part of arch	—18	—67	— 6	—90	+ 18	—113	+ 52	—160

Comparison of measured and calculated stresses (in lbs. per square inch) at the same point:—

	Dead load.		75 Tons.		150 Tons.		225 Tons.		300 Tons.	
	e	i	e	i	e	i	e	i	e	i
Loaded side measured	.....	.....	—335	+ 14	—532	+ 168	—750	+ 330	crack	acting
Loaded side calculated	—119	—154	—315	+ 8	—520	+ 153	—700	+ 194	crack	acting
Unloaded side measured	.....	.....	— 70	—256	— 24	—342	+ 70	—485	+ 231	—707
Unloaded side calculated	—119	—154	— 87	—235	— 8	—356	+ 54	—465	+ 265	—738

equilibrium. Without the hinge the movement at the top could not have taken place and the bridge would probably have broken down before the load had reached 300 tons.

The maximum compression stress is on calculation 2,320 lbs. per square inch under 423 tons load. At the vertical crack the tension stress was 350 tons, 400 lbs. per square

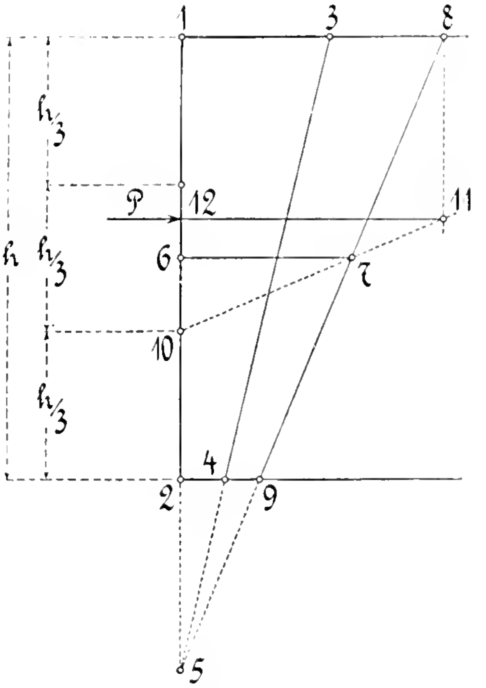


Fig. 7.

inch, and in the unloaded part of the arch the same stresses were found.

The object of measuring the elongations was to determine the position of the pressure line, the value of the acting stresses and to obtain information concerning the modulus of elasticity of the concrete. The main difficulty of those problems consisted in the circumstance that these quantities are exceedingly small, and that the modulus of elasticity is not a constant, but varies with the value of the stresses.

The modulus of elasticity was also fixed in another way independent of the measuring. Two blocks were cut out of the concrete in the arch, from which cubes were sawed with 12-inch side. For two of these not only the compression strength was measured, but at the same time the value of the decrease in length corresponding to each stage of the pressure, by means of which it was possible to determine the moduli of elasticity, thus giving a specially good occasion to test the value of the elongations, stresses and moduli of elasticity figured out after observations on the bridge itself by comparing the values directly found with those found by the cubes.

For the determination of the location of the pressure line and stresses in the arch the following method of procedure was employed:—

From the value of the compression or tension in the highest and lowest point in a section (1—2 in Fig. 7) of the arch (1—3 and 2—4) the position of the neutral axis (5) and from that the acting point of the normal force could be determined. The normal stress (6—7) in the centre line of the section was figured out from the normal force and the area of the section. The normal force could not be measured directly by means of the instruments, but must be taken from the above-mentioned pressure lines (Fig. 6) with corresponding force polygons, which can be designed exceedingly exactly on the basis of the very careful determination of the specific gravity of the concrete, the dimensions of the bridge and the position of the pressures in the hinges.

Assuming a rectilinear distribution of the stresses, the value of these can be found directly by drawing 5—7, which give the stresses 1—8 and 2—9. The acting point of the normal force (12) is located by drawing a line through 7 and the lowest third point, 10, and from the intersection point of the line 10—7 and 8—11 (1—2) a line 11—12 (6—7). The length 1—3 and 2—4 are in this case the sum of the variations in the length from the test-load and the weight of structure; these last-mentioned could not be further measured on the bridge, but should have been measured as the falsework was remote. It was, therefore, necessary to make certain assumptions in order that they might be figured.

The value of the normal force in the unloaded part of the bridge could be directly found in the force polygon, but

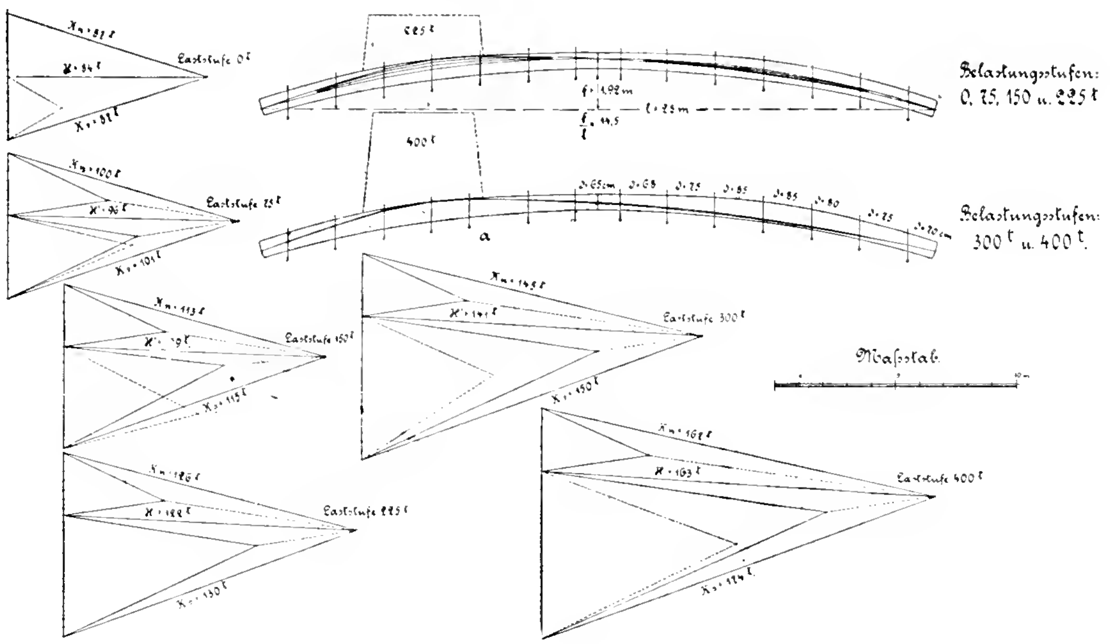


Fig. 6.

the alteration of the length must be figured out from a chosen value of the modulus of elasticity, which was fixed at 5,500,000 lbs. per square inch, after trying different values between 1,500,000 and 8,000,000. This value agrees very well with the laboratory experiments made with the cubes of the seven-year-old concrete, as shown in Table II. The compression experiments are in this case specially valuable, because the line of pressure for the dead load nearly coincides with the centre line of the arch and, therefore, only produces compression stresses.

As proof of the correctness of the situation of the pressure line and value of stresses found in this way, the sizes figured out by the statical examination serve.

reached in this case by means of the strongly concentrated load over the centre of one part of the arch was 2,740 lbs. per square inch, the concrete originally having been figured out with a permissible stress of 560 lbs. per square inch. By this five times increased stress no indication of the destruction of the concrete could be seen.

2. Although the arch was very flat and the pressure line close to the centre line, it was still possible, in this case by the special arrangement of the loading material, to develop tension cracks. As above mentioned, the tension strength was about 350 lbs. per square inch. As the tensile strength has been entirely neglected in the calculations, the structure has a further safety in this high value.

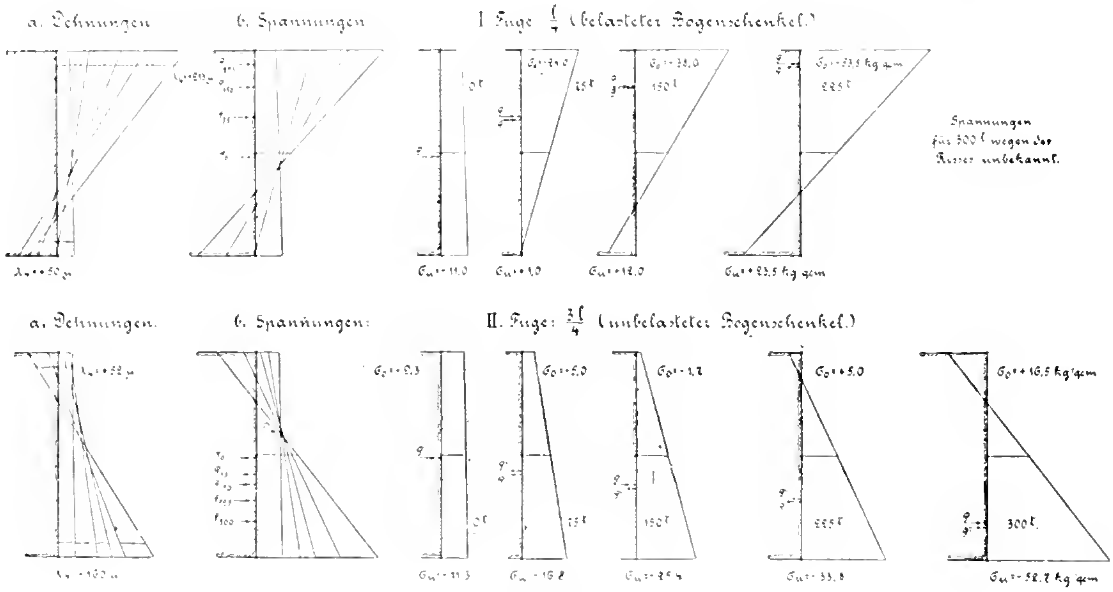


Fig. 8.

In Fig. 8. is given a graphical representation of the alteration in the length, found by Frunckle's apparatus and the hereafter calculated stresses, for one section of the loaded part of the arch (above in the Fig.) and one in the unloaded, both situated one-fourth of the span from the springing lines. Under a are given the elongations (and shortenings); under b the stresses (in kg. per c.m.^{2}). P in the diagrams means the normal load found by the experiment and P^1 the one found by the calculation. It will be noted that the stresses vary in a very satisfactory manner.

The results of the two different ways of determining the stresses are given in Table III.

As a summary of the test-loading on the bridge the following may be given:—

1. As the bridge is merely constructed to resist compression forces, the compression stresses found by the experiment are of greatest interest. The greatest value of these,

3. For giving an approximation of the weight of steel used, it may be compared with the common 23-ton steam rollers. On the same area, which was filled with steel, four rollers, with a total weight of 92 tons, could be placed; the load used by the experiment was thus $\frac{423}{92} = 4.6$ times greater than this quite exceptional loading.

The bridge, during use, has probably had a still greater bearing strength due to the distributing ability of the fill concrete over the arch and because an increase of the dead load in ratio to the live load moderates the movement of the pressure line.

4. The hinges have been very useful; without them the new stage of equilibrium could not take place, and the bridge would have collapsed under a much smaller load than it was able to carry, as it had free movement at three points.

UNITED STATES STEEL CORPORATION IN CANADA.

Mr. James A. Farrell, president of the United States Steel Corporation in testifying as to the corporation's export trade in the United States Government suit, referred to the Canadian business in part as follows:—

"Through Montreal we sell about 60,000 tons of wire product a year, sheet iron, mine rails, and sometimes standard rails, when they cannot be supplied by their own corporations. We are now supplying the Canadian Northern Railway with 25,000 tons of rails shipped by boat from Chicago and thence by rail to Calgary, where they cost $47.13, delivered.

"At Vancouver we supply much material, but the freight rate from Pittsburgh there is $18 a ton. Material from Liverpool or Antwerp may be shipped for $6 to $8 a ton. After we established our office there we found it necessary to run a steamship service there. Our ships leave about every two months, making stops all along the line. On the return we go into a general merchandising business."

INVESTIGATION OF METHODS OF OPERATING THE PITTSBURGH SLOW SAND WATER FILTRATION WORKS.

In July, 1910, George A. Johnson, consulting engineer of New York, was engaged by Hon. W. A. Magee, mayor of Pittsburgh, Pa., to make an investigation of certain features of construction and existing methods of operation of the slow sand water filtration works completed by that city in 1908 at a total cost of some $6,000,000. Mr. R. S. Weston, of Boston, Mass., was associated with Mr. Johnson on studies relating to the chemical phases of the problem.

The practical result of Mr. Johnson's investigation are set forth in the last annual report of Mr. Chas. A. Finley, superintendent of the Water Bureau. Abstracts from Mr. Finley's report follow:—

"It is noted with satisfaction that the total operating and maintenance charge for the year is almost $50,000 less than the cost of last year's operations. The total for the past year was $818,626.12; for the previous year $868,141.07. Most of this saving is due to the improved methods of operating the filtration plant, the saving in operation at this plant during the last year being about $40,000."

"The operation of the filtration plant for the past year has been attended with gratifying results from a financial and sanitary point of view, due to the fact that, with the improved methods of sand handling instituted last year, we were able to operate the plant about $40,000 cheaper than the cost of operating by the methods previously employed."

"It appeared, from an examination of the records, that the operating cost of our plant was unnecessarily bigh. It also appeared that, at certain seasons, we got unusually small yields from filters between cleanings."

"The question thus naturally divided itself along two lines:

"1st. A study of the actual operating conditions within the filters, such as methods employed for sand handling, etc.

"2nd. A study of the physical and chemical properties of the river water, for the purpose of devising methods of eliminating from the river water the causes of the excessive clogging, prior to its application to the sand filters.

"The first question has been handled and investigated by Mr. Johnson.

"The second question has been handled and investigated by Mr. Johnson and Mr. Weston, acting in conjunction.

"These investigations began in July, 1910, and extended over about eighteen months' time, to January, 1912.

"The principal changes in operating conditions within the filters were the introduction of the process of 'raking' the filters between 'scrapings,' thereby securing additional yields from the filters at less expense than by continuous scraping, and a change in the process of restoring sand from restoring by machine to restoring from open hose lines under water."

"The study of the physical and chemical properties of the river water was of necessity complicated and protracted, due to wide variation in the character of the water on account of seasonal and other changes. The investigations were continued until all the different types of water had been encountered, a large amount of data was compiled, careful study made thereof, and conclusions drawn therefrom."

"In line with the conclusions, a system for the preliminary treatment of the river water was designed, and the necessary contract plans prepared for the construction of the same."

"The result of these investigations indicates that the daily capacity of the plant can be increased from one hundred and twenty-five million gallons to two hundred million gallons without the construction of additional sand filters. The amount of water yielded by a filter between cleanings is an essential factor in the increased capacity of the plant. The prime object of preliminary treatment is the assurance of the necessary field between cleanings. With this yield assured, the rate of filtration, or the amount of water filtered daily through each filter, can be increased so as to produce a total daily yield of two hundred million gallons, and still maintain the economy of operation in sand handling."

"To arrive at this total daily capacity by slow sand filters, without preliminary treatment, under the present conditions, would require the construction of about thirty additional slow sand filters of one acre each. The approximate cost of this installation would be over two million dollars, not including the necessary land."

"The annual saving in sand handling alone is $40,000, with the plant as it now stands, and if we consider the difference in cost between the extension of the present sand filters, without preliminary treatment, and the introduction of preliminary treatment, without extending the sand filters, as developed by the investigation, said differences being, in round numbers, about $1,600,000, exclusive of land, and allow 5 per cent. annually on this saving, it amounts to $80,000, which, with the $40,000 saved in operation, makes a total of $120,000."

TRACK CONSTRUCTION ON PAVED STREETS.

At the recent convention of the American Railway Engineering Association one of the committees recommended the following practice on paved street construction:—

They recommended that treated ties should be used and should be laid on a bed of crushed rock, gravel or other suitable material, not less than 8 in. nor more than 12 in. in depth, placed in about 3-in. layers, each to be thoroughly rammed to compact it.

Vitrified tile drains were recommended to be not less than 6 in. in diameter, with open joints and leading to nearest point from which efficient drainage might be obtained or with sufficient outlets to reach sewers or drainage basins. These should be laid on either side of and between tracks, parallel with ballast line and outside of ties.

It was recommended that a 141-lb. girder rail of 9-in. depth, or one of similar section, with suitable tie-plates and screw spikes, should be used. The track should be filled in with crushed rock, gravel or other suitable material, allowing for a 2-in. cushion of sand to support the finished pavement.

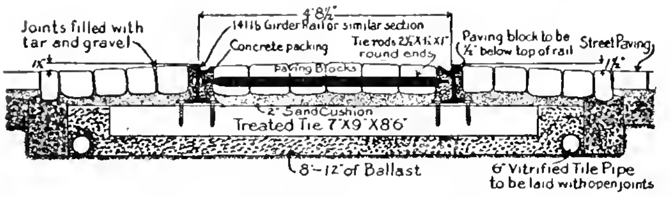
Ballast for paving foundation should be well rammed as it is installed. Two inches of good, sharp sand should be placed on top of the ballast. Paving should conform with municipal requirements, granite or trap rock blocks preferred. Hot tar and gravel should be poured into joints as a binder.

A test which may be of interest was one on cleaning stone ballast by the use of screens. The results of this test tended to show that a gang of twelve men, properly equipped with tools, would cover about 165 ft. of double track per day of ten hours, making the cost per mile of double track $640. This cost included the work of cleaning the ballast, dressing the track and disposing of the dirt. The labor charge included a foreman at $2.40 and eleven laborers at $1.60 each.

The report of the committee on buildings included a brief report on the advantages and disadvantages of various types of fright house floor construction in part as follows:—

Freight House Floors.—"Freight house floors should ordinarily be built to carry a uniformly distributed load of at least 250 lbs. per sq. ft. Except for small houses, a filled-in floor, considering the cost of maintenance, is ordinarily cheaper than joist construction. It is also advantageous, because it will carry the unusually heavy loads that sometimes occur.

"The usual method of construction consists of filling up to the required level with sand or gravel, thoroughly flushed and compacted. To ensure a dry floor, on this filling is laid a bed of ciuders about 6 in. thick, thoroughly compacted. In the cinders are bedded sleepers, preferably about 4 in. x 6 in., laid flat, about 2-ft. 6-in. centers. These and the plank above them should be thoroughly treated with creosote of zinc chloride where there is to be an additional



Recommended Track Construction for Steam Railroads at Paved Street Crossings.

wearing surface applied. With untreated timber renewal is sometimes necessary within four years, though under favorable conditions a life considerably greater is usually obtained. When no cinders are used on top of the sand the decay seems to be hastened.

"In place of cinder filling and sleepers a layer of coal-tar pitch spread upon a layer of sand over a course of concrete is being quite extensively used. This is durable and is said to give good results. Specifications for this method are obtainable from the coal-tar producers.

"Either on the sleepers, laid in cinders, or on the pitch are laid planks about 2 in. thick. With the pitch sub-floor the plank should be laid with broken joints toenailed and embedded in the pitch by hammering until the proper stability is obtained. Care should be taken to see that they are brought to an exact grade. The plank need not necessarily be toenailed with the wooden sleepers.

"To get a smooth-wearing surface on top of the plank hard maple is generally preferable. It does not splinter and it wears evenly. It has a short life when exposed to the weather. It is growing scarce and getting expensive. Beech is often sold for maple, they being difficult to distinguish. It is somewhat darker in color and it splinters more. Birch is softer than beech or hard maple, but does not splinter so readily as beech.

"Gum, especially tupelo, is recommended as a substitute for maple, and it probably will, to some extent, displace it. It is darker in color and somewhat softer, but it wears evenly and it does not splinter much more than maple. Thorough seasoning is particularly essential. There is a large supply of gum in the South and its use for floors should be extensive.

"Under most conditions, the best floor can be had by laying the top floor diagonally, putting the plank lengthwise and the sleepers crosswise of the house, without any bearing on the side walls. Inequalities in settlement of the floor are then less liable to make trouble, the plank can be laid with minimum expense, and the top floor gives the best results after considerable wear. This costs for the top slightly more for laying and more for repairs. Where there is a pronounced amount of trucking in one route it is sometimes thought desirable to put the flooring parallel to this trucking but where the amount of traffic warrants it would seem best to put a runway of steel plates.

"Wood block pavements may be used in place of the board floor. They are best used on top of a concrete sub-floor, with a 1-in. sand cushion between. With wood blocks care should be taken to obtain sufficient expansion joints, as many floors have failed from a lack of this precaution. One inch for 50 ft. is about the correct amount. Care should also be taken to avoid the use of creosoted blocks where flour or similar articles which are easily damaged by odors are handled. There is also a chance of such damage from tar used in the expansion joints. Zinc chloride is for this reason recommended as a preservative for wood blocks when used for freight house floors. Zinc chloride is cheaper than creosote, and in a freight house the blocks will not suffer from the leaching which takes place when they are exposed to the weather, the main objection to the use of zinc chloride for treatment of cross-ties and paving blocks. It is almost impossible to get this kind of floor as smooth as a maple floor, but if properly laid it tends to wear smooth. It is adapted to points where wear is especially severe, such as are due to the handling of castings and heavy machinery. Its main advantages are in the ease with which it can be repaired. The blocks are ordinarily made of pine. It would seem that gum blocks would be better. Maple blocks are also used, but are expensive.

"Concrete has been used successfully where the wear is not too severe. There is a good deal of chance of damage by falling freight, and its use must be restricted to places where there is little chance of castings and similar articles being handled, unless the top surface is carefully made of the best of hard aggregates. Under such conditions excellent results have been obtained.

"A concrete sub-floor protected by a layer of asphalt mastic will give excellent results. It will cost more than the concrete floor, but it will not chip and scars made in its surface soon disappear. It is not so cold as the concrete floor and has been used for this purpose with success.

"Asphalt blocks properly made would seem to have some advantage for this purpose. They should make a smoother floor than the wood blocks and can be more easily repaired than the mastic floor."

RAILWAYS AND CIVIC WORKS AT REGINA, SASK.

The following civic works will be carried out this year:—Street railway extensions, $825,000; gas plant investigations, $25,000; trunk sewer (48-inch), $240,000; waterworks extension, $200,000; storm sewer mains, $60,000; power plant (new one), $425,000; electric light extensions, $250,000; health and scavenging equipment, $117,000; road making, $22,000; fire hall and motor equipment, $60,000; footbridge over Canadian Pacific Railway tracks, $35,000; winter fair auditorium, $134,000; police station and court, $180,000; hospital addition, $125,000; complete subways, $37,000; remodel market building, $7,500; domestic sewer mains, $630,000; domestic water mains, $420,000; paving, $580,000; paving (under old by-law), $550,000, (debentures sold); concrete sidewalks, $115,000; collegiate extension, $100,000.

As a railway centre Regina occupies a fine position. All three of the great transcontinental lines operate in and out of Regina. The Canadian Pacific Railway was the pioneer, but the Canadian Northern and the Grand Trunk Pacific has entered into an agreement with the city council to spend $1,000,000 on the erection of a large hotel, which will contain 275 sleeping rooms. This railway will also erect a large station at a cost of about $500,000. About eight hundred feet of train sheds will be built adjoining the station so that all trains arriving in the city will be under cover.

SOME WATER SUPPLY PROBLEMS OF THE WEST.*

By R. O. Wynne-Roberts, M. Inst. C.E., M. Can. Soc. C.E., F.R. San. Inst., etc., Consulting Engineer, Regina.

Owing to the gentleman who had arrauged to read a paper to-night finding he had to leave the city, and would, therefore, not be able to fulfil his engagement, and, as the time was too short for others to fill the breach, it is to be hoped that the following note will furnish topics for discussion:—

Every country, district and town has water supply problems to solve. It is rare to find nature so generous as to furnish abundant, pure supply of water without leaving some difficulty, more or less great, for the engineer to surmount. We have only to study the conditions in Canada, which, perhaps, possesses the most bountiful supply of water of any country, to observe that a number of towns and cities are combatting with one difficulty or another. The supply of water is either difficult to procure, or it is limited in quantity, or it is not pure.

Whilst in the East and extreme West of Canada there is abundance of water, the problem in many places in the Middle West is to find a copious and pure supply, and it will be well to consider why it is often so difficult.

The author has during his career had a number of water problems to deal with, but when he visited Regina and was asked by the corporation, through your president, who was then City Commissioner, to conduct investigations with the view to augmenting the supply, he found new conditions, which had to be carefully studied.

Geological Formation.—One of many interesting features which had to be studied was that of the geological formation of the country, and in this connection it may be useful to describe the agencies which primarily contributed to form the topographical features of this part of the country.

The present surface is entirely of glacial origin. When the first great ice invasion of the glacial epoch moved southwards the surface of the country was doubtless much more rugged than it is to-day, and the valleys possibly drained in other directions. The great sheet of ice, many hundreds of feet in thickness, advanced slowly southwards, stripping loose material, crushing and levelling rocky hills; stones, gravel and mud became frozen to the ice, and increased the power of the glacier to wear down other rocky excrescences, etc. Enormous masses of crushed rock of many kinds were thus picked up and conveyed from the northern parts across this country into the United States. When the climate became warmer the ice gradually melted back, and huge streams of water, which flowed down from the ice sheets, and brought with them great quantities of detrital material, depositing the same in uneven masses, filling up valleys and forming the plains and hills which constitute the principal features of the prairies.

Where this great ice sheet halted from time to time terminal moraines were formed.

The second ice invasion again changed the surface of a large part of the country, disturbing the deposits left by its predecessor and redepositing the same.

These ice sheets advanced across Canada into the United States in the form of a huge tongue, and the glacial deposits can be found over vast territories. These masses of glaciated material vary in thickness, magnitude, shape, character, and distribution, and were laid in a most chaotic manner. The districts around Regina, for instance, are from 1,900 to 2,400 feet above sea-level, and about 600 to 1,100 feet above the Lake Agassiz, which was formed in the glacial period. This lake and other glacial lakes extended westward [illegible]s the Elbow on the South Saskatchewan River.

The channels or ravines cut out by the stream[illegible]g from the ice sheets have been gradually or partially [illegible] in by sand, silt and gravel washed out of the mor[illegible] deposits, building up the gentle slopes and flat plains [illegible]tween the banks. During the ages that have since elapsed the streams have eroded passages through these outwash plains, and in places undercutting the beds of drift, thereby tapping the underground water-bearing stratas and causing springs to appear on the surface.

The fine silt or mud, composed of disintegrated cretaceous rocks, which were carried by the ice sheets, formed the flat or very slightly undulating land surface of the prairies, which constitute the major portion of the country south of Regina. This material, called till, consists of pulverized rock forming impalpably fine clay mud, often intermixed with gravel, boulders and rock. This till, bluish-grey in color, although oxidized on the surface and underneath for a few feet to yellowish clay, is to be found over the country, extending to the Central States of America. It usually underlies the gravel deposits, and forms a more or less impervious substratum. The upper portion of this till is commonly softer and easily dug, while below it there is a sudden change to a hard and compact deposit, locally called hardpan. The probable cause of this (according to Mr. Upham) was the pressure of the enormous weight of the ice sheet upon the lower and older till, while the upper till was dropped loosely as the ice melted. The boulders, which are more or less plenty on the ridges and in valleys, are generally granite, gneiss, and schists brought from the northwest, and also limestone—the latter, being softer and more easily crushed, has been largely reduced to gravel, etc.; hence it is that the substratum consists mostly of limestone and clay.

It is important to note that the glacial till, consisting of a matrix of clay with pebbles and boulders, and, forming a more or less watertight mass, has intermingled and interbedded with it in a most extraordinary manner, and often lying above and below it porous water-laid sands and gravels, which constitute the water-bearing strata. In many places these beds of sand and gravel lie between two beds or till of different epochs of formation, but in a greater number of districts gravel beds of varying depths, thickness and character are to be found under the clay bed drift. It is, however, not possible to trace these beds for a great distance. The calcareous matter has been leached out of the older formation, but in the more recent accumulation it virtually remains without change; consequently, the water obtained for the latter beds are heavily charged with mineral salts.

The surficial layer of drift is generally open and fairly loose, with the result that water percolates rather freely into the subsoil. Owing to the uneven manner in which the glacial materials were deposited and to the undulating nature of the surface, it is inefficiently drained; there is a plexus of pools, sloughs, and swamps. The drift is often saturated nearly or even to the surface; hence it is that so many farmers are able to obtain a fairly abundant supply of water from shallow wells. In times of drought, however, the water table will be considerably reduced, and in some instances it will probably sink below the bottom of such wells. This is also the main reason why sloughs appear to dry up in seasons of drought.

In the case of the outwash sands and gravels to be found stretching out from the moraines, these beds, being very porous, readily absorb the rain falling upon them.

Sand dunes are found in some places, like Pilot Butte. These were formed by sand from the plains drifting with the winder and heaped up in cones or dunes or drifting sandhills. The time of formation of these dunes was probably

* Paper read before the Regina Engineering Society.

soon after the recession of the ice sheets and before vegetation had spread over their surface.

Rainfall.—The question which arises after ascertaining the areas of the possible watersheds is the quantity of rain falling on such sheds, more especially in prolonged periods of drought.

As a fairly typical example, we might consider Regina district. There are two rainfall observation stations on which the rainfall in the Regina district may be relied upon. These are the North-West Mounted Police barracks and Qu'Appelle. These, however, do not accurately represent the rainfall on the watersheds east and north-east of Regina, because the stations are lower than the waterheds in question.

By analysis of the recorded rainfall at these stations the mean annual rainfall is computed at about 16 inches. The next step to take is to ascertain the rainfall in any three driest consecutive years. The above-mentioned records were carefully examined, and it was found that it amounted to about 10.4 inches, or 65 per cent. of the mean annual precipitation.

Evaporation.—The problem that has to be next investigated is that of evaporation that takes place on the surface of the water and land. Part of the rain percolates into the ground to feed the water-bearing strata springs, etc., and sustain vegetation, another part is lost by drainage off the surface of the land into the streams, and a portion is evaporated. In the West, however, snow remains on the ground for months. The ground is frozen to a considerable depth; consequently, not much water percolates down to the substrata during winter. It must be remembered that evaporation goes on throughout the winter; when the spring arrives, much of the remaining water, in the form of snow and ice, when melted will drain away. Furthermore, in summer, some of the water which has percolated into the ground is absorbed by vegetation and then transpired into the atmosphere. There are, however, several depressions in the land surface, such at kettle-holes, etc., which retain water until it disappears into the ground or is evaporated. The phenomena of evaporation is an interesting one, and it is to be hoped that the Government will some day arrange for careful observations over a prolonged period to be made, for it has a very material influence on the question of water supply, irrigation, agriculture, etc. In general terms, evaporation is a product of many conditions, such as temperature of the air and water, duration and intensity of solar rays, the dryness and velocity of the air, etc. Evaporation increases with rainfall, but is much more uniform in districts of large rainfall, and in districts of low rainfall it is relatively high. So, in years of drought especially evaporation constitutes a very important factor in the problem of water supply.

The United States Government has conducted a long series of evaporation on the Salton Sea, California, where it was found that the evaporation ranged from 51 inches in 1908 to 69 inches in 1910. In Ohio it was 46 inches. It may be estimated that from the surface of water it is approximately 50 inches in the West, but what is lost by evaporation from the land surfaces is not possible to estimate at present.

Yield.—The yield from watersheds varies in every case, owing to the difference in physical features, such as mountains, valleys, as contrasted with flat or undulating prairies, rocky catchments as compared with porous plains, luxuriant vegetation, trees and foliage on the one hand and "prairie wool" on the other.

In the case of Regina water supply, after taking into consideration the many conditions and approximate similarity with water sheds in the States, it is estimated that by laying extensive collection pipe lines and sinking wells about one and one-quarter inches out of ten inches rain in the three driest consecutive years can be secured, but it cannot be assumed that a similar yield can be obtained from any other watershed in the prairie provinces, for it might be exceeded or be far less, as eveyrthing depends on local features.

There are available for Regina about 200 square miles of watersheds, and at the above rate it is estimated that about ten million gallons can be collected and delivered into the city.

Tapping the Supply.—Having ascertained what extent of catchments are available, the minimum rainfall in driest years, estimated the losses by floods, evaporation, absorption, and what is collectable, it then remains to be decided how best to tap the supply.

This depends on several conditions, such as topography of the district, substrata in which the water is expected to be found, inclination of the water-bearing stratas, etc.

While the author was conducting the investigations into the question of augmenting the water supply, he visited over two hundred farmers, and from them obtained information as to the nature of the stratas through which they sank wells and in which they found water; he also inspected over 800 square miles of country, and by this and other means in many places was able to locate the existence of water-bearing stratas, the direction in which they dipped, and the area of the watersheds. The author recommended sinking wells in Boggy Creek, where works had already been started, as it was the lowest point in that part of the catchment which could be utilized, and also the laying of collecting pipe lines in various directions.

Wells.—Authority was obtained to carry out the recommendations, and in April, 1912, the first well was sunk 108 feet, when a large volue of water overflowed at a height of twelve feet above ground. This well has continued to overflow at the rate of about 150,000 gallons per day. Up to the present time eighteen wells have been sunk, of which ten are overflowing, five are choked and three were unsatisfactory. The choked ones can be cleaned when necessary. Some of these wells are five inches in diameter and the rest are seven inches. They vary in depth from 65 feet to 192 feet. The underground pressure and the velocity of flow in some instances were too great to maintain a constant supply, as the large volume of water gushing out of the wells induced too great a current in the water-bearing strata, and this caused sand and other materials to be conveyed with the stream and choke the wells referred to. To overcome this difficulty it was decided to sink other wells in their immediate vicinity so as to relieve the pressure, and this has been partly successful. In some cases quicksand and soft clay cause trouble.

The stratas through which the wells were sunk were as follows:—

No. 2.	Feet.	No. 5.	Feet.	No. 17.	Feet.
Clay	6	Clay	38	Mud and clay.	40
Coarse sand	20	Clay and gravel	5	Sand and gravel	2
Fine sand and clay	8	Gravel	30	Clay and sand	13
Fine sand	13	Yellow sand and quicksand	17	Fine sand	17
Gravel and sand	3	Clay and hardpan	10	Quicksand and clay	60
Sand	21			Hard clay	25
Hardpan	4			Clay and sand	18
Depth	75	Depth	100	Depth	175

The author, in October last, was consulted by the Carlyle town council in connection with the augmentation of the supply of water. After making an inspection of the district around, the council was advised to sink a well on a certain

patch of land. This well was sunk in April, 1913, and at a depth of 192 feet water was found under conditions which were predicted in the report.

Quality of Water.—Well water in the prairie districts is charged with lime salts, caused by contact with different kinds of limestone. This is common to almost all well waters in the West. As already stated, when the ice sheets were passing over the country a large quantity of rock was transported. The harder rocks survived the process of crushing better than the soft rocks; hence it is that in some districts hard rock boulders are to be found on the surface. It is estimated by the geologists that about 90 per cent. of the surface boulders are of hard rock and 10 per cent. soft rock, but in the substrata the proportions are reversed, and we find 90 per cent. of gravel is limestones of various kinds.

Water readily absorbs salts and gases, and, consequently, in its passage through the soil and different stratas, mineral salts are being absorbed. In addition to salts, water absorbs gases, and, as carbonic acid gas is present in the air and in the ground, it is taken up by the water, and this increases its solvent powers. When the water finds an outlet to the atmosphere, such as in the form of springs, some of the carbonic acid gas is lost and it becomes less heavily charged with lime and, consequently, a limited natural softening process takes place.

The water as supplied to Regina, for instance, contains carbonate and sulphate of lime and carbonate and sulphate of magnesia and other chemical constituents. These salts cause the water to be "hard," and the problem is how best to soften it. Hard water used in boilers causes sludge and scale to be formed, and these in time not only reduce the efficiency of the boiler, but also tend to cause overheating of the plates and other troubles.

The hardness of water is usually divided into two classes, namely, temporary hardness and permanent hardness. As already explained, water absorbs lime salts more readily when it contains carbonic acid gas. By heating the water, this gas is driven out and the carbonate of lime held in solution by means of such gas becomes insoluble, and its greater part, together with magnesium carbonate, is precipitated and forms sludge. Temporary hardness is that part of the total hardness which is precipitated by boiling.

Boiling will not have the same action on the sulphate, chloride or nitrate of lime or magnesia, as these salts remain soluble. Permanent hardness represents these salts as well as the parts of the carbonates of lime and magnesia not precipitated by boiling. Temporary and permanent hardness, however, are relative terms, to denote the characteristics of hard waters.

Apart from the use of hard water for industrial purposes, it is of importance to consider it from the domestic viewpoint. One part of carbonate of lime decomposes 6.12 parts of stearate of sodium, and, as soap usually contains only 60 to 70 per cent. of stearate of sodium, about 9.5 (say, 10) parts of soap are required. Consequently, if 100,000 gallons of water per day are consumed in washing, cleaning and other purposes, in which operations soap is necessary, it is a simple calculation to ascertain the consumption of soap necessary to produce lather.

Each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is equivalent to 10,000 gallons of water, requires about ten pounds of soap to obtain lather. This is equal to 100 pounds per 100,000 gallons. Water obtained from wells in the prairies contains, say, 20 parts of carbonate of lime per 100,000, so that the total theoretical consumption of soap will be 2,000 pounds per 100,000 gallons.

Soap is retailed at about ten cents per pound; therefore, one ton of soap will cost about $200, or about $2 per 1,000 gallons.

We will now consider softening of the water by means of lime. Carbonate of lime, $CaCo_3$, is nearly insoluble, but when carbonic acid gas is present, soluble bicarbonate of lime is formed. Dr. Clark's process, which has been in operation all the world over, in one form or other, for about half a century, consists of adding quicklime or slaked lime to the water, with the result that the active lime at once combines not only with the excess dissolved carbonic acid in the water and forms the practically insoluble carbonate of lime, but also robs the bicarbonate of lime of its semi-combined carbonic acid, so as to effect practically a total precipitation of all the lime present as carbonate. The active lime thus effects exactly the same result as would be produced by boiling.

In softening water by adding lime, theoretically, 0.56 parts of quicklime is required to remove each one part of carbonate of lime in 100,000 parts of water. In practice, however, more quicklime is required. Adopting the same basis for calculation, as is the case of the soap consumption, each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is the same as 10,000 gallons of water, requires 0.56 parts or pounds of quicklime to remove the carbonate of lime. This is equal to 5.6 pounds per 100,000 gallons. The water contains, say, 20 parts of carbonate of lime per 100,000, so 112 pounds of quicklime are necessary. With lime at one cent. per pound, the cost of softening such water is $1.12 per 100,000 gallons, or 12 cents per 1,000 gallons. The actual cost will probably be nearly twice as much. It will thus be observed that softening by lime is, theoretically, about eighteen times cheaper than by soap.

Prairie water, however, as already stated, contains other salts than carbonate of lime, and we will see what it means to adopt a softening process to reduce them to an economical minimum. That will mean the adding of quicklime as well as soda ash.

Assuming that prairie well water contains:—

20 parts per 100,000 of calcium carbonate.
3 parts per 100,000 of magnesium carbonate.
15 parts per 100,000 of magnesium sulphate.

The quantity of quicklime to remove the calcium carbonate with the theoretical amount already mentioned, 112 pounds per 100,000 gallons.

The theoretical quantity of soda ash necessary to remove most of the magnesium carbonate will be 37.6 pounds, and to remove the magnesium sulphate 130 pounds per 100,000 gallons.

The cost will, theoretically, be:—

112 pounds of lime at one cent per pound....	$1.12
167.6 pounds of soda ash at three cents......	5.03
Total	$6.15

The cost of lime and soda is, therefore, equal to about six cents per 1,000 gallons, but in actual practice it will be more. To this must be added the cost of labor, supervision, capital charges, etc. As the cost is high, it is desirable to ascertain to what extent the hardness can be reduced, having regard to our local conditions with respect to cost of labor and materials. But this the author will not follow further at present.

Before any softening scheme can be undertaken with any degree of confidence and satisfaction, it is essential to obtain results of mineral analysis of the water to be treated, which is different to sanitary analysis. It must be clearly understood that the foregoing figures are only approximations submitted to illustrate the nature of the problems confronting the engineers in the West.

Before leaving the question of water softening it will doubtless be interesting to refer to another process, which is now before the public, and that is the Permutit process. Permutit is the trade name of an artificial zeolyte produced by a process invented by Dr. Gans, of Berlin. Germany. This material is granular in form, much line coarse, grey sand. It is usually placed between layers of fine gravel in a filter bed or tank. As the water passes through the permutit and exchange takes place. The sodium in the permutit exchanges with the calcium and magnesium in the water, and by this means the hardness of the water is reduced to zero. When the permutit has lost its power of exchange, or, in other words, it is exhausted, it can be revived by saturating it with a solution of common salt. In this case the sodium in the salt is exchanged for the calcium absorbed by the permutit, and, when the exchange is complete, the filter is washed and is ready for softening a further quantity of hard water.

There are a large number of water softening plants on the market, all worked on the same principle, but differ somewhat in details in the method of proportioning the lime and soda, and in the general arrangements, but it will be impossible in the space of this short paper to discuss them. The selection of plant suitable for Western waters so as to obtain uniform results at as low a cost as possible requires full consideration.

Sterilization.—As all waters in the West are more or less liable to pollution, it is necessary to adopt some means of sterilization. In this case there are several ways of sterilizing water, such as by ultra-violet rays, by chlorination, and by ozonation. The most popular method at present of sterilizing water is by adding a very small proportion of hypochlorite of lime, often as little as half a pound per 100,000 gallons, or one-half part per million. The quantity of sterilizer required depends, of course, on the quality of the water to be treated. This is a subject which would alone suffice to occupy an evening, and, consequently, can now only be touched upon as indicating one of the problems to be dealt with.

Filtration.—Towns situated near rivers or streams would seem to be much more fortunate as regards water supply than those remote from such streams; but it often occurs that the river water is polluted and muddy, or both, and problem is to effectually eliminate the mud or pollution. This is done by means of coagulation, settling basins, filters, etc.

In the West, climate, especially in winter, is rigorous; the temperature at times falls as low as minus 50 degrees Fahrenheit. Open settling basins and filters are, consequently, out of the question. They must be covered, and this increases the cost considerably, and some means has to be found by which the cost may be kept at a reasonable minimum. Temperature stresses are often greater than the stresses due to weight of water or earth, and, as solid masonry possesses elasticity only to a small degree, reinforced concrete would appear to be more suitable for works which are subject to expansion and contraction, due to a great range of temperature. The steel embedded in the concrete tends to distribute the stresses and prevents concentrated contraction or expansion. The author has observed on an excellently built dam, exposed to a less range of temperature than is experienced in the West, fractures in two or three places from top to bottom, splitting huge masonry blocks. In reinforced concrete structures, correctly designed and carefully built, such fractures are not so localized, owing to the greater distribution of stresses by the steel reinforcements.

Settling basins and filters can, of course, be built in reinforced concrete. It is a question worthy of careful consideration whether rapid mechanical filtration is more suitable and economical for muddy and impure waters drawn from rivers.

Water containing comminuted clay mud is difficult to treat without adding some coagulant. In New Orleans, clay was held in suspension in Mississippi water after many weeks' storage in settling tanks.

At Lorenzo Marques (Delagoa Bay) water very heavily charged with clay is satisfactorily clarified and purified by means of coagulation and filtration.

Prefilters are adopted in many places, especially on the European continent, to remove heavier sediment, and so relieve the ordinary filters of much work, and also secure greater purification.

There are some parts of the West where it is stated to be practically impossible to obtain water. Efforts have been made in some instances to discover water by means of electrical and other devices, and it would be interesting and instructive to know the results.

Having regard to the difficulty of finding an adequate water supply in portions of this province, and its consequent retardent effect on the development of the same, the Dominion Government has had plans prepared for drawing water from the South Saskatchewan River for distribution in the districts in question. In this scheme it is proposed to construct a dam across the river to generate electrical power for pumping the water through the conduits over the high banks The provincial government also, it is understood, is making investigations into this matter. This action on the part of the government only emphasizes the points already referred to in this paper with regard to the problems in connection with water supply in the West.

Distribution.—The last problem to be discussed in this paper is that of the distribution of water in the towns and cities. It is noticed, according to the press, that almost every city in Canada has a problem to solve in respect to the system of distribution mains. This question constitutes an important feature of city planning, for without city planning it is almost impossible to satisfactorily provide for the future. It may seem strange to include the supply of water in city planning, but it must be remembered that it concerns everything which will contribute to the material progress and prosperity of a city.

In the West, perhaps more than elsewhere, the growth of the population is so great that it is difficult to extend works of public utility collaterally with the expansion of the city. A village often grows into a town and then into a city in a remarkably short time, and it taxes its financial resources to provide water, sewers, streets, lights, etc., to all parts of a district as it is being built upon. But it is not a difficult matter to plan out a town or city ahead of its expansion and design the system of distribution mains and other works, so as to be sufficient for a city many times its present size, without incurring undue financial burdens on the present ratepayers. It will doubtless be recognized that it is much more costly to alter and enlarge works than it is to provide ample dimensions at first, especially in a country where towns increase so rapidly.

The actual facts are, that the authorities generally provide only for the present. Mains are, therefore, laid from time to time, and these are extended in various directions without first carefully considering what will be the ultimate result.

This possible development was foreseen by your president when city commissioner, and his successor, City Commissioner L. A. Thornton, with the author, submitted a joint report to the Regina City Council recommending a scheme of distribution mains, such as will suffice for a much larger city.

It was pointed out in the report that when any water mains are being laid in any part of the city they should conform as closely as possible to the sizes and directions shown on the plan attached to the report, so that whatever is done will ultimately constitute a part of the complete scheme.

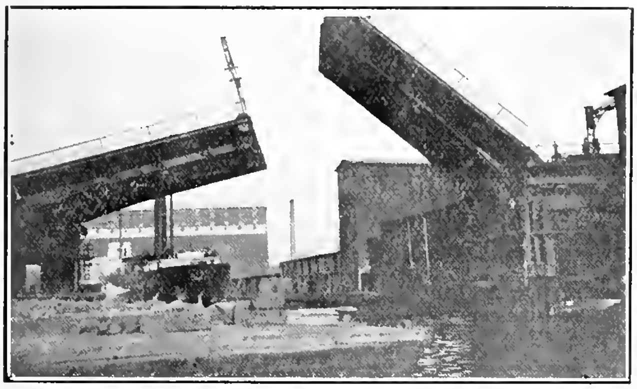
Although engineers have no greater insight into the future than other persons, they can at any rate calculate the probable population in different sections of the city and design works of adequate capacity, so that when any portion is being carried out from time to time, it will form a part of a satisfactory scheme of distribution.

In conclusion, there are doubtles many other problems which could with profit be dealt with in this paper, but time and opportunity have not been sufficient, yet it is to be hoped that what is presented will furnish ample topics for criticism and discussion.

SPEED OF DRAWBRIDGE OPERATION AND ITS VALUE.

By Henry Grattan Tyrrell, C.E.

The required speed of operation depends upon the location and natural conditions. Where the river banks are high, so that nearly all river travel can pass under the bridge, the speed of operation for the few openings required for tall-masted ships is not so essential as when the deck is near water, making it necessary to open the bridge for all kinds of craft, big and little. In remote places for only occasional service, a slow movement, perhaps by hand-power, may be permissible, as in the Nyasaland vertical lift bridge in South Africa, which is operated by eight men in twenty-five



Sixth Street Bascule in Milwaukee; One of the Most Recent Designs.

minutes, or the Hooghly pontoon draw at Calcutta which requires fifteen to twenty minutes to open it and as long to close it again. On the other hand, in busy cities and especially at low-level crossings, it is important to economize every second of time, and to install the most rapid operating machinery.

Swing bridges usually take from four to six minutes for a complete cycle, and this is facilitated by having the bridge so designed that the ends are reversible, and the bridge can then follow a boat around and continue moving in one direction. More time is needed if the bridge must open in one direction and after coming to a stop and waiting for the boat to pass, start up motion again in the reverse direction for closing. By continuous moving in one direction the swing bridges on the Tyne at Newcastle (1877) made a complete circuit in 2½ to 3 minutes. Bascules have the quickest movement, for the amount of lift can be suited to the size of boat, while a swing must perform a complete revolution for a craft of any kind, either large or small. The modern bascules in Rotterdam can be opened in 15 to 20 seconds in calm weather, and the experience with these structures in Holland cannot be surpassed, since that country is so extensively provided with canals and waterways. The speed is affected to some extent by the presence of snow and water on the floor, for these influence the balance and necessitate a little more power and time, and this provision becomes more serious in the colder districts, such as in lower Quebec, or in Western Canada, where the winter is more severe.

The importance of rapid operation in cities, such as at Vancouver in British Columbia, can best be appreciated by an example. A bridge which has 100 openings per day, of five minutes each, will delay street travel for a total period of eight hours, or one-third of the time, five to six hours of which will be during the day, or nearly half the working hours.

The economic speed of operation, and the investment which is permissible to secure it, or to reduce delays for any particular case, can readily be determined. Observation must be made of the nature and amount of travel on both street and river, and the number of water craft that would require a bridge opening. The value of public time which can be saved by the introduction of more adequate machinery will represent the interest on the investment which is permissible. The matter is easily understood by an example. The saving to the public by placing the bridge high enough to avoid too frequent openings is illustrated by one of the openings bridges at New York. The old low bridge, only eight feet above the water, had been opened on an average of forty times per day, while the new one, with an under clearance of 24 feet, needed opening only twelve times per day, though the new and heavier bridge had a slightly slower movement than its predecessor.

The saving of public time by the higher bridge was $4,000 per year, which is equivalent to 4 per cent. on $100,000. It was therefore economical to spend $100,000 additional on the new bridge to secure the greater under clearance and fewer openings.

These conditions apply wherever opening bridges are used, such as along the Canadian system of canals from lakes to the Atlantic, and on the proposed new canals from Georgian Bay eastward.

From forthcoming treatise entitled "Movable Bridges." By H. G. Tyrrell; 800 pages. Ready for press.

CAPITAL CHANGES.

The following companies have increased their capital stock: Dunlop Tire and Rubber Goods Company, Limited, from $993,000 to $1,300,000, by the issue of 3,070 shares of new preference stock of $100 each; the Walkerville Light and Power Company, Limited, from $25,000 to $100,000, by the issue of 750 shares of new stock of $100 each; the Hercules Garment Company, Limited, from $20,000 to $50,000, the increase consisting of 300 shares of $100 each; the Security Lumber Company, Limited, from $500,000 to $750,000, the increase consisting of 2,500 shares of $100 each; the Maritime Nail Company, Limited, from $250,000 to $3,250,000, the increase consisting of 30,000 shares of $100; the Carritte-Paterson Manufacturing Company, Limited, from $50,000 to $300,000, the increase to be divided into 2,500 shares of $100 each.

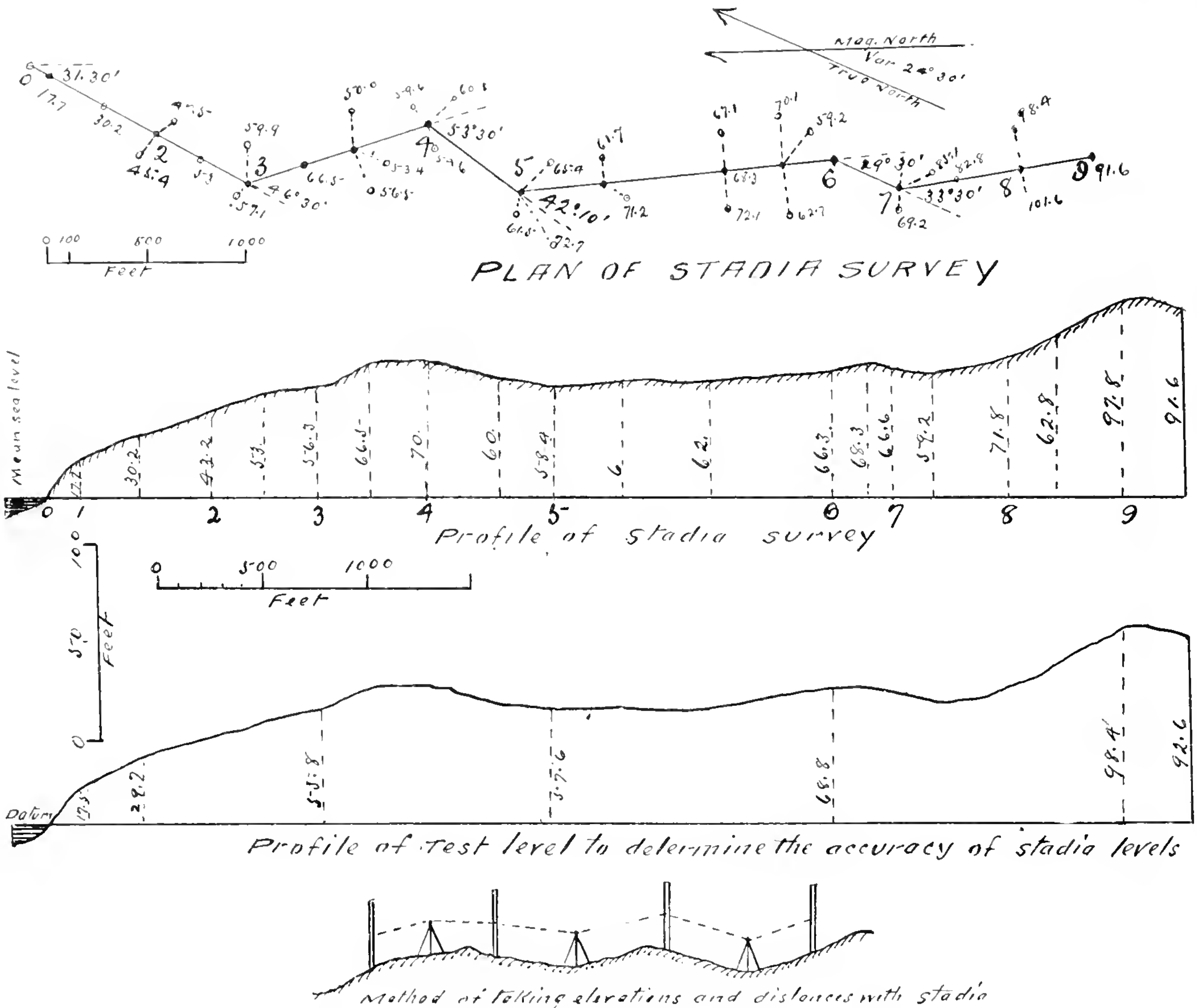
PRELIMINARY RAILWAY SURVEYING BY MEANS OF THE STADIA.

By J. A. Macdonald.*

In the present case the survey was started from mean sea level, that is, a point in the Gulf of St. Lawrence; not that the railway was intended to run to the sea (which it yet may) but in order to obtain a reliable and definite datum. At this point of starting there was quite a bank to the water's edge at mean tide. The transit was set up on the bank above and very carefully levelled. The rod was held at approximately the water's edge when it was judged by calculation, as well as observation, to be mean tide. The vertical angle to the rod was, as shown in the field book, —14°55 and the distance read on the rod .71. These data corrected gave an elevation of 17.7 feet and a distance of 65 The bearing by the compass was N. 31.30 E. This bearing was used. By an observation it was found that the difference between the magnetic bearing and the astronomical bearing was 24°30′, that is, the needle varied 24°–30′ west. Both are shown on the plan.

The next sight forward was S. 31.30 W. and an azimuth of 211°30, the distance by rod reading was 3.20, the angle elevation +2°15′, which equalled a distance of 319 and a difference of level, or elevation, of 12.5 on a point on the tangent. From stat. 2 to stat. 3 the same bearing, S. 31.30 W., was produced, and points taken on either sides of the line to determine the topography. A point on the tangent 211°30 gave elevation 53. (above sea level). Left, 142°00′; distance, 1.13 (reduced to 109); vertical angle, +2°15′; difference of level 4.3 and elevation 47.5. Right, 312°30′; distance, 1.10 (reduced to 109); vertical angle +1°10′; difference of level, +2.2; elevation, 45.4. A hub, of course, was set at stat. 2. At stat. 3, a lock sight being taken, points were taken on either side before deflecting the angle. A point left 97°00′ gave distance 1.82 and difference of level 3.6; right, 291°00′, 83 for distance and 8′ vertical. Another point, right, 328°00′, gave rod reading 1.10 (reduced to 109); vertical angle 1°00′; difference of level, 1.8. A deflection angle of 46°30 was made and the same procedure gone on with. A form of the field book with notes for the beginning of the survey is appended.

In this way the topography of the country was obtained to great exactness. Only about half the number of men were required on the line than if a regular transit, level and topographic parties were maintained, and equal results were produced, though not so rapidly.



Characteristics of Stadia Surveying.

* Department of the Interior, Ottawa.

To test the accuracy of the stadia levels, a run of regular levels were made on the first portion of the line, a profile of which is given. It was found that the variations between the stadia calculations and the level were very little when the stadia observations were calculated by the regular methods.

This surveying with stadia means much work in camp in reducing and calculating the sights, but in a country where there is not much bush it is a rapid and satisfactory method. The regular party can be divided into two stadia parties for running the preliminary line. For exploration lines in new country it is an excellent method. The map-plans and profiles well illustrates the methods employed.

Station	Def. Angle	Bearing of Tangent	Points taken	Azimuths	Distance (Stadia reading)	Distance corrected	Vertical Angles	Compt. Diff. of Elevations	Elevations	Remarks
1	31°30	N.E. 31.30		31°30	.71	65	−14.55	−17.7	17.7	Mean Sea Level
			Tan	211 30	3.20	319	+2.15	+125	30.2	
2		S.W. 31.30	Tan	31 30	3.06	305	+2.30	+13	43.2	
			Tan	211 30	2.70	269	2.05	+9.8	53.0	
			Left	142.	1.13	109	+2.15	+4.3	47.5	
			Right	312.30	1.10	109	+1.10	+2.2	45.4	
3			Tan	31.30	2.30	229	−.50	−3.3	56.8	
			Left	97.	1.82	181	+1.10	3.6	59.9	
			Right	291.	.83	82	+30	.8	57.1	
			Right	328.	1.10	109	+1.00	+1.18	58.1	
	46°30′	S.E. 15.	Tan	165.	2.70	368	+2.05	+9.7	66.2	
4			Tan	345.	3.03	302	−.45	−4.	70.	

One locating engineer, in particular, on the National Transcontinental Railway, several years ago, when the writer was working on the line, employed the stadia for most of his preliminary lines, and for all of his exploration lines. He divided his party into two units, one in charge of the transitman and the other in charge of the leveller. As a stadia party only requires about one-half the number of men to carry on the work satisfactorily that a transit party needs, he was in this way enabled to cover twice the area of ground than if he employed the transit alone.

At that time, in the wilds of Northwestern Ontario nothing comparatively was known of the country north of the Canadian Pacific Railway. There was no map of that wide range of country from Winnipeg east to Lake Nipigon. The country around Lake Nipigon was partly mapped. East of Lake Nipigon to Lake Abitibi was little known nor further east. The railway explorers sent in by the Grand Trunk Pacific in 1904-05-06, entered a dense wilderness, and were under great disadvantages. On entering this wilderness these hardy engineers were like a ship in mid-ocean without beacon, buoys or landmarks, and like the sailors on board ship, were forced to take astronomical observations for latitude, longitude and azimuth to find their bearings and make a start mapping the country by means of exploratory surveys. It was on these surveys that the value of the stadia was first prominently brought into play in Canadian railway surveying. The country west of Lake Nipigon was covered by lakes large and small. One could scarcely go a mile without striking a small lake. The larger lakes had to be traversed in order to map it. Here the stadia was used entirely. Very rapid work in the traversing of lakes was accomplished with the stadia. In this way was the country mapped and made possible for the final location.

WATER WASTE INVESTIGATION.

Water waste in our Canadian cities is a familiar subject, but we have not heard so much about waste in the smaller towns. W. D. Gerber, consulting engineer, of Chicago, presented a paper on this subject before the Illinois Water Supply Association, an abstract of which we publish herewith.

The curtailment of water waste is particularly desirable in places which secure their water supplies from deep or artesian wells. The continual draft on the wells has lowered the ground water level to such an extent that serious problems are presented in getting the water to the surface. With a less severe demand on such wells we may reasonably expect their life to be materially lengthened.

Those towns which draw their supply from rivers or other surface waters must, of course, treat such water to render it suitable for domestic purposes. These treatment plants, besides the treatment tanks and filters, usually have connected therewith large clear water reservoirs for the storage of a considerable quantity of the treated water. The capacity of the treatment plant, including the reservoir, is usually designed upon the consumption, and the consumption is usually taken as a factor of the total daily displacement of the pump plungers. If a large percentage of the pumpage is waste, we can readily see that the works will be designed too large for the immediate needs of the community, and with a consequent expenditure of funds that in many cities can be ill afforded.

In the design, then, of new equipment, and, subsequently, if the station is to be operated on an efficient and economical basis, and the supply conserved, all unnecessary pumping should be eliminated.

The causes of this unnecessary pumping or water waste can usually be grouped under five heads: Pump slip, underground leakage, defective plumbing, carelessness, or wilful waste and surreptitious connections.

With pumps of the direct acting or non-flywheel type, there is frequent complaint that the pumps pound, and several arrangements have been supplied to produce more of a cushion at the end of the stroke. This cushioning has the effect of shortening the stroke and, of course, thus reducing the volume of pumpage. The pump counter, however, goes on counting the number of revolutions, and the daily report card shows so many revolutions at full capacity as the volume of water pumped.

Pump slip is not, properly speaking, a water waste, but is rather a waste of pumping effort, and should be kept as low as is practical. Just where this practical limit is we do not know exactly, but undoubtedly the same limit would not apply to all cities or to all types of pumps. About all we can say is that the practical limit is the point where the value of the water gained through close-fitting plunger and valves would be less than the value of the additional power required to overcome the added friction due to the tight packing. However, an allowable slip of 3 to 5 per cent. does not seem to be out of line with good operation and practice.

The detection of underground leakage is a very different matter than that of discovering and measuring pump slip. The distribution mains are covered up and we can only guess at what has taken place by a detail study of the pumping chart. The demand or consumption for a few hours after midnight, say, from 12 to 4 o'clock, is frequently indicative of the tightness of the system. At this time of the day the consumption is, or should be, at its minimum, while if the relative demand is high it is an indication that something is wrong.

There is always some leakage from the mains that cannot be checked, and it is usual to allow a loss of 2,000 gals.

per minute of 12-inch pipe, while for sizes other than 12 inches, the allowable loss is taken in the same proportion as the ratio of the diameters. One drop a second is not much of a leakage, and yet one drop a second from every joint in a mile of pipe would amount to approximately 1,400 gals. in 24 hours.

When the volume of consumption is abnormally high, there is reason to suspect that there are are unaccounted for losses, and the best way to satisfy oneself on the matter is to have a water waste survey made.

As an instance of what such a survey may accomplish, I wish to cite the results obtained in a city of some 3,500 people, in which the waterworks is owned by a private corporation. For some years the pumpage had been excessively large. Repeated appears to the consumers to be more careful brought no apparent relief, and finally an additional source of supply was developed entailing an expenditure of $10,000. This increased the available amount of water, but the volume of the pumpage in no way diminished, but rather increased. During April and the early part of May of last year the average daily pumpage varied from 680,000 to 700,000 gals. per 24 hours. A water waste survey located a blown-out lead joint in an 8-inch main wasting more than 300,000 gals. per day. This leak occurred under a broken stone-filled roadway, and behind a stone arch bridge at a point where the pipe was 14 feet below the street surface. The water was finding a ready outlet into the creek. Had this waste been discovered and stopped prior to the development of the new supply, the company would have been $10,000 better off in cash, and would have felt much easier in regard to the adequacy of their supply.

Another instance is a city of 2,000 population. The city operates a motor-driven 400,000-gal. triplex pump. From October, 1911, to June, 1912, it was necessary to operate the pump practically all the time to keep up the pressure, and even at that it seemed impossible to fill a 100-ft. standpipe more than half full. A water waste survey was made and a 4-inch pipe was found cracked squarely in two, permitting a leakage of 200,000 gals. per day, which found a ready outlet in an abandoned 12-inch tile storm water sewer, which crossed directly over the crack about 8 inches above the water main. There was no indication at the street surface of any such leak, though the pipe was laid but 4 feet deep, in fact the ground was not wet 2 feet away from the break. Incidentally I might add that the pump slippage was 25 per cent., leaving a consumption of about 100,000 gals. or 50 gals. per capita per day.

The method of making these surveys was substantially the same in both cases. At a point near the standpipe, an opening was made in the ground down to the main, and a 1-inch corporation tap was placed in the pipe in the usual way. A pitometer, which is a portable recording meter, was set up at this point, and a measurement of the flow during the night when the station was shut down was made. The city was then divided off into a number of districts, and during the day all the valves on the boundary line of the districts were closed, except one, which was left open to supply water to the district. That night after one o'clock this last valve in each district was closed, and the time when the valve went down was recorded. The rule was to begin at the outlying district and work toward the instrument. As each district was closed off from the supply the valves between it and the foregoing district were opened, so that when the night work was finished all the valves would be left open.

A comparison of the time each district was closed down, with the chart from the instrument, disclosed the district in which the loss occurred, for the minute the valve went down, which cut off the leak, the instrument recorded a drop in the rate of flow from the standpipe.

With the location of the loss in any particular district, it is generally a comparatively simple matter to locate the point of leakage by using an Aquaphone on the fire hydrants and sill cocks of the residences. Sometimes, however, the final location of the leakage is not so simple, and it is necessary to make a subdivision of the district, in this way usually the suspected territory may be reduced to a few blocks at the most.

The subdivision of a district into its smallest units is usually the method required when the losses are from defective plumbing, and in addition it is necessary to make a house to house inspection of the entire plumbing in each building. Carelessness in making proper plumbing repairs seems to be more prevalent in cities where the water is sold at a flat rate, the installation of meters having a wholesome effect on this class of consumers.

Carelessness as to fixture waste and wilful or deliberate waste are like defective plumbing, confined largely to the systems supplying water at flat rates. The sentiment seems to exist that so long as one is paying so much, what is the use of being careful, "We are entitled to all we can get out of the fixtures." This sentiment really reacts against the consumers, for with everyone in the same frame of mind the system becomes virtually a sieve, and of course the pressure is always low, especially in territory some distance from the pumping station. It all comes home to him in case of fire and no pressure.

Where such conditions exist it is sometimes a tedious task to locate and correct such losses, and the only way it can be done successfully is by a minute subdivision of the district, and night tests in the curb cock, together with daylight inspection of the individual premises. The returns in the value of the water saved usually far exceed the cost of doing the work.

Surreptitious or uncharted connections may occur almost anywhere, though they seem to be more frequent in the manufacturing districts of the larger cities. The making of a connection to a city water main by a private person or corporation is, of course, a deliberate intent to get something for nothing. Very frequently such connections are made from the fire service lines, which are extended into the grounds of the individual or company.

Where a survey indicates that there are surreptitious connections, the only way of definitely locating them is to segregate the suspected plant and measure the total amount of water going into the same. This, together with a very careful inspection of the fire lines and legitimate services, will usually produce a solution of the problem. It is needless to mention, however, that such work must be quietly and carefully done that correct results may be obtained.

It is a very unpleasant charge to make, but nevertheless it is true that in many of our cities and villages no record is kept of the location of the house service, and when the top of the curb box gets broken off or covered up, the service is "lost," and in case of repair or an order to shut off the service much time is lost in looking for the old box. In such cases the exact location of the service pipe can be quickly located by the use of a small electrical instrument called "A wireless pipe finder," and with the line of the service located in the ground, the shut-off box can be quite easily located by the use of a miner's compass, or as it is frequently called, a dip needle.

The latter instrument also comes in quite handy in locating street valves on the mains in unpaved streets where the boxes have been covered up by a road grader in crowning or shaping the surface of the street.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **60** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."
Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.
London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, MAY 22, 1913. No. 21

CONTENTS OF THIS ISSUE.

EXPERT EVIDENCE.

A strong opposition to the present metho[illegible]ing expert evidence in cases at law, and a [illegible] feeling that expert witnesses should be desig[illegible] the Courts, led the American Institute of Co[illegible] Engineers to hold a discussion on this most import[illegible] subject a short time ago.

The discussion brought out many interesting facts and viewpoints which have a direct bearing on existing conditions in this country. The present custom here, as in the United States, is for each side in a controversy to employ its own expert witnesses, just as it employs other witnesses, and the experts are examined and cross-examined in the same manner as ordinary witnesses. After summing up the opinions offered and in closing the discussion the chairman referred to a class of questions that require expert testimony, which can only be furnished by professional engineers, such as the valuation of public utilities, conflicting claims of water power companies, and the like. In such cases he felt time would be saved and the cases would be better presented if studied from ex parte points of view before the action at law is begun. The appointment of engineer associates by the court would probably be helpful in clearing up conflicting and confusing testimony.

Throughout the discussion a number of the speakers spoke of the importance of effecting a reform in expert practice by insistence on a higher standard of professional etiquette. It is doubtful if this would be a sufficient remedy. Better conditions can only be brought about by joint action of the engineering and legal professions.

STREAM AND RIVER IMPROVEMENT.

The necessity for the proper conservation of the water resources of the Dominion, and their utilization for the maximum benefit of the public has often been emphasized in these columns. We are prone, however, to neglect the placing of the necessary safeguards until it is too late, or until force of circumstances compels action.

Coal consumption is advancing at a rapid pace, so rapid, in fact, that complete depletion of the present available supply is only a matter of a very few years. We have not the figures to hand for Canada, but in the United States, in 1890, 2.54 tons of coal per capita were used, or a total of about 158,000,000 tons; in 1912, 5.73 tons per capita were used, or a total of 550,000,000 tons. It is certain that the increasing per capita consumption and the increasing population will deplete the supply at a much higher rate. The logical outcome will be that in a very short time, probably less than twenty-five years, the United States will prohibit the export of coal.

As Ontario has no coal resources of her own necessity will force the development of many of our water powers, which are today either too far from the market for commercial development, or too costly for economic use.

Water power development on a large scale is a product of recent years, and attention has often been called to this fact as the reason for its subservience to older institutions. We have grown firmly fixed in the habit of considering our streams as intended primarily for navigation, and are, therefore, prone to overlook the fact that in some cases a stream may have a higher utility as a source of municipal water supply or for irrigation or for power.

The ever-increasing demand for electric power must be met by the increased development of hydro-electric projects of greater capital cost. Water storage will be a necessary adjunct to many of these developments, and the public will then properly appreciate the value and importance of gauging records.

In a recent issue of Conservation, in referring to the dangers of over-estimation of available power, the following pertinent remarks are made: that engineers consider the problem simpler and easier than it really is; that they have not the necessary data, and that, lacking these, they have failed to acquire properly experienced judgment in such matters. This only emphasizes the need of governmental aid in providing adequate funds for the securing of continuous records of stream flow.

It is important to remember that streams can be put to many uses. The interests of navigation should only be given their proper weight in the matter of river improvement. Water-power development, municipal water supply, irrigation supply, the reclamation and protection of flooded lands, and the other incidental uses of water must receive due attention if the maximum utility to the public is to be secured.

EDITORIAL COMMENT.

In a recent paper before the American Institution of Electrical Engineers Mr. Esheleman remarks that when winding coils for electric machinery he found he could only earn $1.10 on the night shift, while on the day shift he earned quite $2. Moreover, while only 5 per cent. of the coils wound in the day time failed to pass the insulation test, as many as 10-15 per cent. of those done at night were rejected. This is quoted as an example of the disastrous effect of imperfect artificial illumination on the speed and quality of work.

* * * *

Testifying recently before the Commons Committee on pollution of streams, Dr. C. A. Hodgetts, chief medical health officer of the Conservation Commission, declared in favor of a Federal department of health with wide powers. He said: "Health Acts in Canada are nice to look at, but are not enforced," he said. "Municipalities do what they please, and there is no central power to say "You must do this." There is nothing in the B.N.A. Act which relegates public health control to the province." Dr. Connell, of Kingston, said that cities such as Montreal, Ottawa, and Toronto polluted their own water supplies with sewage, and that every city should be compelled to treat its sewage. He considered the St. Lawrence was polluted for sixty to eighty miles below Montreal.

* * * *

The idea of electrifying the railways seems to have got a firm hold of the public mind in Sweden, and much progress towards carrying it into execution has been made already. The first great step is the electrification of the Kiiruna Railway from Kiiruna to the Norwegian frontier. This work has been advanced rapidly of late. A start has been made with the building of the transformer stations, and it is anticipated that the whole line will be opened for regular traffic in the course of this year. Satisfactory progress has also been made with the line between Stockholm and Saltsjöbaden, which is also to be completed this year. The State Railways besides have made extensive experiments with two Diesel electrical locomotives, which have given very satisfactory results, while five private lines have had the question of electrification examined by experts for the working out of estimates as to the cost, etc.

* * * *

A steamer intended for the Hydrographic Service of the Canadian Government was launched from the Neptune Works of Swan, Hunter & Wigham Richardson, Limited, on Thursday, the 8th inst. The vessel is 170 feet in length by 33½ feet beam, and will be built to attain the highest class in Lloyds' Register. She will be propelled by a set of triple expansion engines, supplied with steam by two boilers working under Howden's forced draught, both engines and boilers being constructed at the Neptune Works, and expected to drive the vessel at 12 knots per hour. The steamer will be schooner rigged. She is built of steel, and strengthened to enable her to run through ice, and will be completely outfitted for her intended service, having two motor launches, Lucas sounding machine, marine sentry, sounding winch, electric light, with projector, etc. Besides the usual accommodation for the deck and engine-room officers, there will be well-furnished rooms for the various officials engaged in survey work. The vessel is being constructed to the designs and under the superintendence of Mr. R. L. Newman, of Canada, whose representative in England is Mr. F. L. Warren, of London, and both Mr. Newman and Mr. Warren were present at the launch. As the steamer left the ways she was named the "Acadia," the naming ceremony being gracefully performed by Miss Hilda Thompson, daughter of Mr. R. Thompson, consulting engineer, of London.

THE WATERWORKS AND SEWAGE SYSTEMS OF CANADA.

Some few years ago *The Canadian Engineer* published a table showing the water consumption in various cities throughout Canada, together with other data covering the plants then in existence, which table attracted a good deal of attention at the time it was published.

TABLE I

NUMBER OF WATER-WORKS PLANTS IN EACH PROVINCE, CLASSIFIED ACCORDING TO SOURCE OF SUPPLY, MODE OF SUPPLY, POWER USED, ETC.

Province	No. of Plants Supplied From			No. of Plants Using Filters	Mode of Supply		Kind of Power Used					Ownership		Rates on Which Charges Are Made		
	Springs or Wells	Lake	River		Gravity	Pumped	Water-Power	Steam	Electricity	Gas	Gasoline	Municipal	Private	Flat	Meter	Both F. and M.
Nova Scotia	13	12	4	1	19	10	1	9	—	—	—	25	4	18	—	10
New Brunswick	13	1	2	1	7	9	—	6	1	2	—	14	2	11	—	4
P.E. Island	3	—	—	—	1	2	—	2	—	—	—	2	1	—	—	2
Quebec	42	11	41	15	48	46	8	24	11	1	2	57	37	31	—	3
Ontario	69	28	47	19	18	126	21	66	24	7	6	125	19	75	5	55
Manitoba	4	—	4	2	—	8	—	6	—	1	1	8	—	3	3	—
Saskatchewan	12	—	3	3	4	11	—	4	2	—	4	15	—	7	5	2
Alberta	7	—	9	7	4	12	—	8	1	3	—	14	2	10	2	4
British Columbia	14	4	3	2	17	4	—	3	1	—	—	16	5	12	2	5
Canada	177	56	113	50	118	228	30	128	40	14	13	276	70	167	18	85

Table I.

In this connection engineers will, however, be pleased to learn that the Commission of Conservation undertook, some little time ago, to compile statistics covering this phase of engineering in Canada. As a result of their labors they have issued a book which contains a number of very interesting facts, and we are pleased, therefore, to be able to reprint the accompanying tables, taken from the report, which we are sure will be read with a good deal of interest by municipal engineers throughout the country.

The tables are self-explanatory. It is interesting to note the accompanying curve as showing the increase in the number of waterworks plants since 1850. From 1850 to 1875 the development was not very rapid. From 1875 to 1890 the development was much more rapid, and it will be seen that since 1890 to 1910 the development has been fairly constant; whereas in 1880 there were about fifty plants, in 1910 there were something like three hundred and sixty in operation.

TABLE II

NUMBER OF WATER-WORKS PLANTS IN CANADA AT THE BEGINNING OF EACH FIVE YEAR PERIOD, 1850-1911

Province	1850	1855	1860	1865	1870	1875	1880	1885	1890	1895	1900	1905	1911
Nova Scotia	1	1	1	1	2	3	3	5	11	20	24	29	29
New Brunswick	1	1	1	1	1	2	2	4	6	7	9	11	16
P.E. Island	—	—	—		—	—	—	—	1	1	1	2	3
Quebec	—	—	3	4	5	8	17	22	30	44	62	77	96
Ontario	2	3	5	5	5	10	20	28	59	85	100	119	144
Manitoba	—	—	—		—	—	—	—	—	2	3	6	9
Saskatchewan	—	—	—	—	—	—	—	—		—		2	15
Alberta	—	—	—	—	—	—	—	—	—	1	2	4	16
British Columbia	—	—	—	—	—	1	1	2	5	6	13	16	21
Canada	4	5	10	11	13	24	43	61	112	166	211	266	349

Table II.

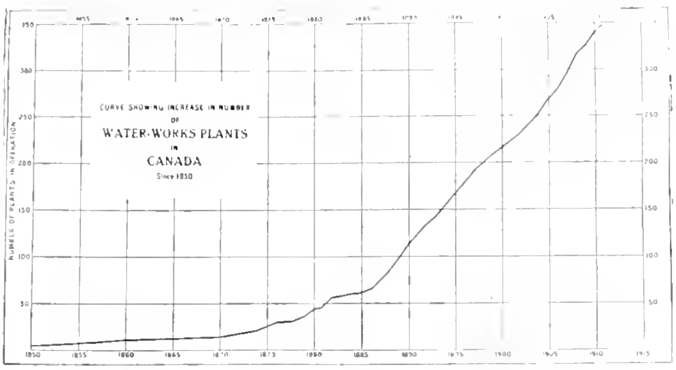
SUMMARY TABLE

TOTAL COST OF PLANTS, CONSUMPTION, MAINTENANCE CHARGES, ETC., FOR THE DIFFERENT PROVINCES

(In this compilation, the items which it was impossible to obtain from the municipalities, have been estimated)

Province	Cost of Plants (dollars)	Total Daily Consumption (imp. gal.)	Annual Maintenance, exclusive of interest (dollars)	Total Length of Mains (miles)	Estimated cost per 1,000 gal.* (cents)	Estimated cost per Capita per year* (dollars)	Daily Consumption per Capita (imp. gal.)
Nova Scotia	4,534,682	21,436,662	176,602	393	7	3.76	147
Pr. Edward Is.	365,506	802,000	11,543	29	16.4	2.87	48
New Brunswick	3,563,939	15,278,500	101,616	186	8.2	4.82	161
Quebec	31,224,883	110,800,000	731,694	1,157	9.5	3.92	113
Ontario	37,813,117	151,203,363	1,601,077	2,182	9.6	4.21	120
Manitoba	4,852,868	9,791,213	251,141	297	20.6	3.40	46
Saskatchewan	2,461,810	4,480,000	131,202	156	23	3.88	46
Alberta	4,485,802	14,685,000	248,589	313	13	6.27	132
British Columbia	6,263,769	26,997,000	181,735	502	8.2	3.44	115
Canada	95,566,496	360,477,638	3,435,199	5,215	10	4.12	113

* These costs are approximate only, and have been calculated from the annual maintenance costs, plus an allowance of 10 per cent. of the cost of plants for interest and for depreciation.



Tables I. and II., together with the summarized table, reveal a number of interesting comparative facts. This interesting and valuable report was prepared by Leo G. Denis, C.E.

Plans for Victoria harbor improvements progress steadily. This year will see the large docks well under way. These are to be built by Sir John Jackson & Company, and something will be accomplished also in connection with the dredging of False Creek in Vancouver. To give better facilities for shipping, it is announced that the government will establish a drydock at Esquimalt, this being stated as part of the naval scheme on the Pacific. Mayor Baxter, of Vancouver, who was in Vancouver in connection with harbor and other matters, returned on the 1st instant, and reports that it is very probable that a drydock will be built at Vancouver along the lines of some of the schemes proposed heretofore.

WATERPROOFING CONCRETE.

To make cement and concrete impervious to water a number of waterproofing materials have been devised, such as "Medusa," sold by Stinson-Reeb Builders' Supply Company, of Montreal; "Pudlo," sold by W. H. Thornhill & Company, of Winnipeg; "J. M.," sold by the Canadian H. W. Johns-Manville Company, Limited; and the "Kahn Paste," sold by the Trussed Concrete Steel Company, of Canada, Limited, etc. The benefit derived from waterproofings of this nature, where resistance to water or dampness is desired, has been well established, and it may, therefore, be of interest to review briefly a few of the claims made by the various manufacturers.

Mr. Kennedy Stinson states that "Medusa" waterproofing does not affect the color, strength, setting or hardening qualities of concrete, and when used in the proper proportions it will make any concrete work impervious to water and prevents discoloration from rain. It prevents the white efflorescence which so often makes cement work unsightly, and also prevents the appearance of hair cracks on the surface. It has been shown by LeChatelier that the destruction of concrete by sea water is due to the diffusion of the sulphates of the water through the mass and the action of these salts on the constituents of the cement.

There is good reason to believe that "Medusa" waterproofing, by preventing this diffusion, will enable concrete to resist perfectly the injurious action of sea water. Mr. Stinson says that by the use of "Medusa," waterproofing qualities will be obtained which could otherwise be secured only by the use of very rich and expensive mixtures. "Medusa" is a dry, white powder consisting of fatty acids chemically combined with lime. It is thoroughly mixed dry with dry cement before the sand and water are added.

The name "Pudlo" is coined from "puddle," which, according to the dictionary, means "to make watertight by means of clay." "There is great loss of labor and loss of space when clay puddle is used for reservoirs, ponds, tanks, etc.," says Mr. Thornhill, "and Pudloed cement means quicker, easier and cheaper work, with all leakages avoided." "Pudlo" is a fine, white powder, which should be mixed with neat cement in varying proportions, according to the purpose for which it is required. It is said to prevent all leakages, making cellars and basements damp resistant, even when built alongside the water's edge. It prevents dampness rising in concrete floors and makes reinforced concrete absolutely dampproof.

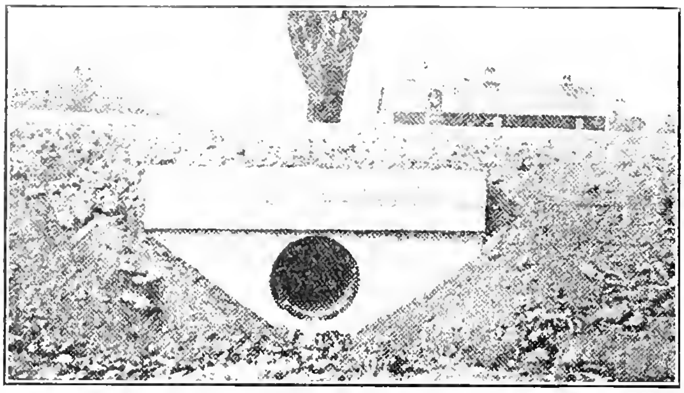
It allows flat roofing to be done in cement. It is said that "Pudlo" completely fills the voids in cement and cement mortar, and slightly increases the strength of same. The manufacture of "Pudlo" is based upon an earthy fat of such a nature that it enters into chemical amalgamation with cementitious substances. A chemical action is set up in the cement, owing to the silica in the cement being absorbed or dissolved by "Pudlo." The presence of hard silica in cement makes it porous. When the silica is dissolved the cement has no crevices left in it and percolation cannot occur. Mr. Thornhill especially calls attention to the advisability of "Pudlo" for sewers, which should certainly be airproof and odor-proof. "Pudlo" will prevent hair cracks and efflorescence on cement work.

The Canadian H. W. Johns-Manville Company state that their "J. M." waterproofings are made of non-organic materials, and are practically everlasting. Their waterproofings have been used for basements, bridges, reservoirs, abutments, mastic floors, etc.

The "Kahn" waterproofings are in the form of a paste, which is dissolved in the water from which the concrete is made. Both paste and powder waterproofings are easily shipped and do not evaporate, so they have a certain amount of advantage in that regard over liquid waterproofings.

CONCRETE CULVERTS FOR COUNTRY ROADS.

In a recent bulletin issued by the North Carolina Geological and Economical Survey there is to be found much valuable information pertaining to the design and construction of concrete waterways for country roads. The bulletin is entitled "Culverts and Small Bridges for Country Roads in North Carolina," by C. R. Thomas, Highway Engineer, U.S. Office of Public Roads, and T. F. Hickerson, Highway Engineer of North Carolina.



Concrete End Wall for Pipe Culvert.

Some of the culverts have been built with Merillat collapsible cores and metal forms have been used by the highway department successfully in the construction of small bridges. The bulletin is in the nature of a textbook of waterways for highway builders, and its treatment of the concrete structure is plain, comprehensive and authoritative.

The following extracts are taken from the bulletin:

Concrete is a properly proportioned mixture of cement, sand and stone, which when mixed with water forms an artificial stone. It is called plain or reinforced depending on whether steel is used to give it additional strength.

Concrete culverts and bridges possess the following merits:

(1) Permanent; (2) Can be built with inexperienced labor; (3) Require no repairs; (4) Materials are readily obtained. On the other hand they must be properly designed and carefully built to be satisfactory.

Concrete Waterways.—Plain and reinforced concrete may be used in all shapes of waterways which usually occur on country roads. The shape to use, whether a pipe, box, slab or arch will usually depend on the location of the structure.

Staking Out: In laying out a waterway the length should first be determined. This is largely a matter of personal choice, but as a general rule structures having 25 square feet area of waterway or less should extend completely across the graded width, no guard rail being necessary; and those having over 25 square feet area of waterway should not be less than 15 feet long, preferably 20 feet.

The foundations are laid out according to the dimensions of the plans. A small stake is placed at each corner and a light cord is stretched between the stakes to serve as a guide in excavating the earth. The character of the soil sometimes makes it necessary to excavate beyond the width required for the concrete. The earth bottom should be trued with a straight edge and level. If footings are used, small stakes may be placed on the sides of the trench with their tops level with the top of the footing and the concrete brought up to them. It is important that the top of the footing should be true, as it is difficult to set the forms on any uneven surface.

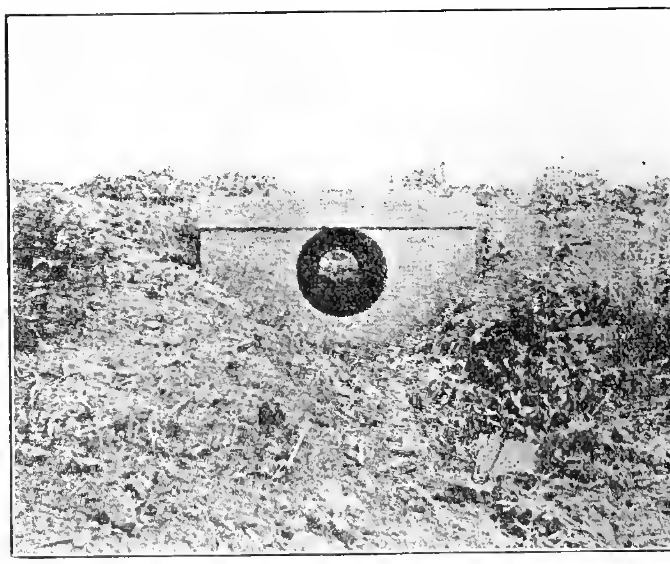
A tape, straight edge, and good carpenter's level are usually all the tools necessary to do the staking out. It is convenient to remember that the sides of a right triangle are in the ratio 3:4:5. For example, when the zero and 12 ft. marks on the tape are held together, and the 3 ft. and 7 ft. marks held along a wall the zero is perpendicular to the wall.

Except in waterways requiring a guard rail it is neither necessary nor advisable that the tops of both parapet walls be at the same elevation.

Methods of Design: All the culverts and bridges illustrated in this bulletin are designed to support a 15-ton road roller. 1:2:4 concrete is used for all slabs, beams, parapet walls, and reinforced bottoms. 1:2½:5 concrete is used in side walls and foundations. The concrete in beams and slabs is designed to be stressed to 700 pounds per square inch. The reinforcing steel is computed for plain square bars of mild steel with an allowable stress of 16,000 pounds per square inch. Round, twisted, or deformed bars may be used in place of these, provided the cross-sectional area of steel remains the same.

Pipe Culverts: Several designs for solid concrete pipe are shown. In building these a collapsible metal form similar to the one illustrated in Plate IV. has been found very convenient.

The form for the half-round culvert should be made of No. 10 gauge sheet metal with a 1½ x 1½-inch angle riveted on the edges, rods with turnbuckles 4 feet apart serving to spring the form. A beveled 2 x 4-inch wooden strip must be placed under each edge in order to strike the form. A piece of No. 10 gauge sheet metal cut to fit the top of the form will serve for an end wall form.



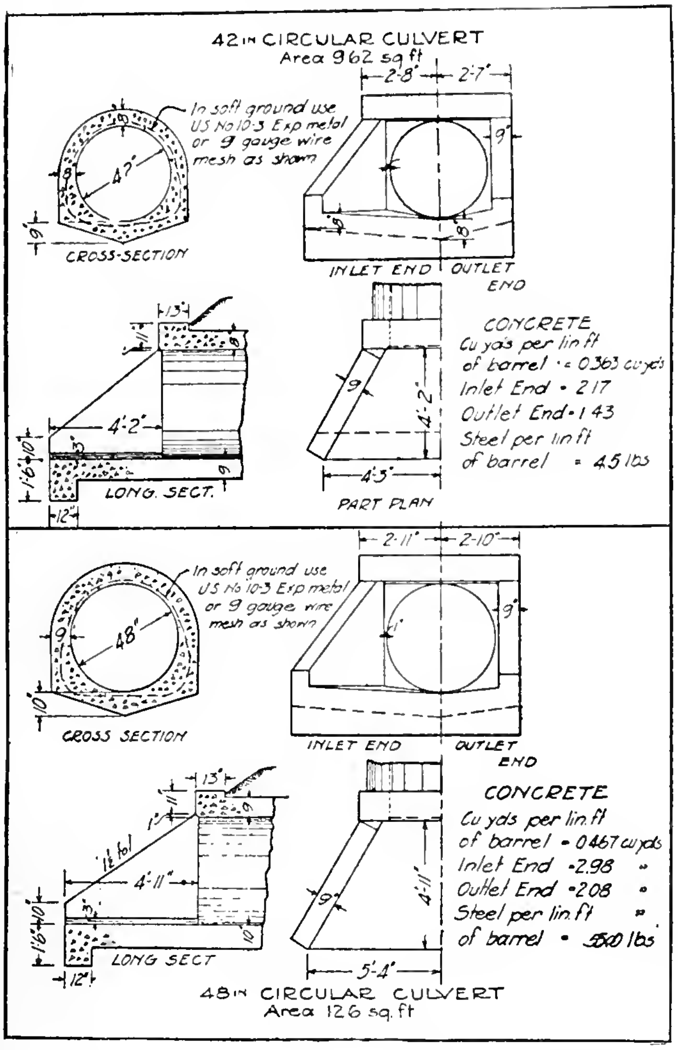
Culvert Made With Collapsible Form.

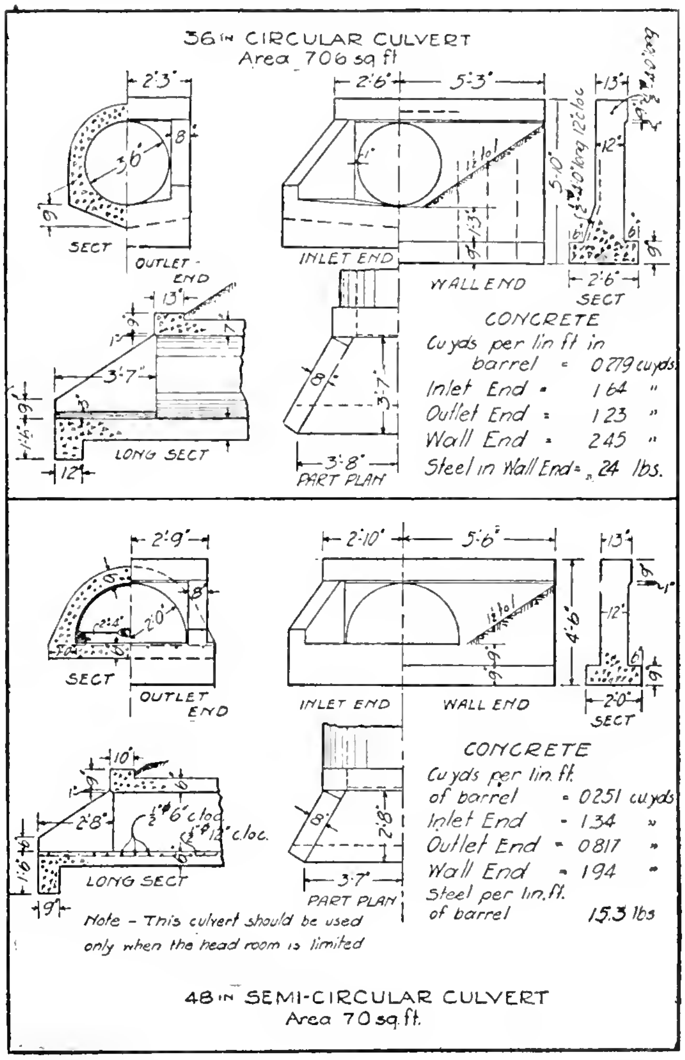
In building these culverts the bottom is put in level and allowed to set, being careful to have it true from end to end. The form is then placed and the concrete deposited for the length of the section. After 24 hours the form may be withdrawn and set for the next section of the pipe. Ordinarily no wooden forms are necessary except for the end walls.

Box Culverts: Plates VIII. and XI. are photographs of various types of end-walls for box culverts. Expanded metal or triangular wire mesh reinforcement may be used in place

of the rods. These culverts are provided with baffle walls which in some cases, may be omitted at the upper end. At the lower end it may sometimes be necessary to increase the depth of the baffle wall or to place a baffle wall under the wings as well as at the end. In striking the inside forms the joists supporting the top of the culvert are knocked out, the top forms drop down and the side forms spring in. It is often possible to excavate the trench to the exact size and shape of the culvert, doing away with outside forms. However, the side walls must be thicker when this is done.

Guard Rails: Either pipe or solid concrete rails may be used on the concrete structures described. Pipe guard rails are cheap, sightly and on the whole, satisfactory, although they require some maintenance. They may be supported while the concrete is being placed, as shown in Fig. 11.





They should be given a thin coat of red lead and oil, followed by two good coats of white lead and oil after the bridge is completed. Pipe railing will cost about $0.50 per linear foot of single rail.

Concrete rails are very sightly but are difficult to construct and very expensive and are not recommended for ordinary country work.

Cost of Concrete.—The cost of concrete in small structures on country roads will vary somewhat from its cost in town or on large jobs. A main point of difference is probably in the cost of materials delivered on the job. Another difference comes in the delay and expense of continually moving the plant from one point to another.

The cost of hauling material to the work [illegible] 30 cents per cubic yard for every mile it must be hauled. An ordinary wide tread, slat bottom wagon bed containing a cubic yard is 38 ins. x 8 ft. 6 ins. x 12 ins. in size, inside dimensions, and is usually as much as the average team can handle over bad roads. An inch added to the height of the side boards increases the capacity of the bed .083 cubic yard.

Loading sand or gravel into a wagon bed will cost from 7 cents to 10 cents per cubic yard where shovels are kept busy, but may cost as high as 15 cents when the driver loads his own wagon.

A small gang with four good men mixing and one man shoveling material into barrows and putting on water, should mix and wheel 40 or 50 feet from 8 to 10 batches or 6 to 8 cubic yards of 1:2½:5 concrete, assuming a batch contains one barrel (four bags) of cement. The cost of this mixing will vary from 80 cents to $1.15 per cubic yard.

On small jobs where new forms are required, the cost of framing and erecting the forms will never be less than $12 to $15 per 1,000 ft. B.M. of lumber used, due to the large amount of cutting and fitting necessary. On larger jobs the cost may be reduced to $8 to $10 per 1,000 ft. B.M. These costs are much less when old forms are used. Lumber will cost from $22.50 to $30 per 1,000 ft. B.M. Steel rods will cost from 1¾c. to 2¼c. per pound, delivered in most sections of the state.

The labor cost of bending and placing steel is about ½ cent per pound. This will be increased slightly if many rods greater than ¾ inch in diameter must be cut cold.

The cost of excavating for foundations will vary from 50 to 80 cents per cubic yard in dry earth and will generally vary between $1.50 and $3 per cubic yard where small puddle cofferdams not over 6 feet deep must be built.

Tearing down forms, finishing and cleaning up around the work will usually cost about 10 cents per cubic yard of concrete.

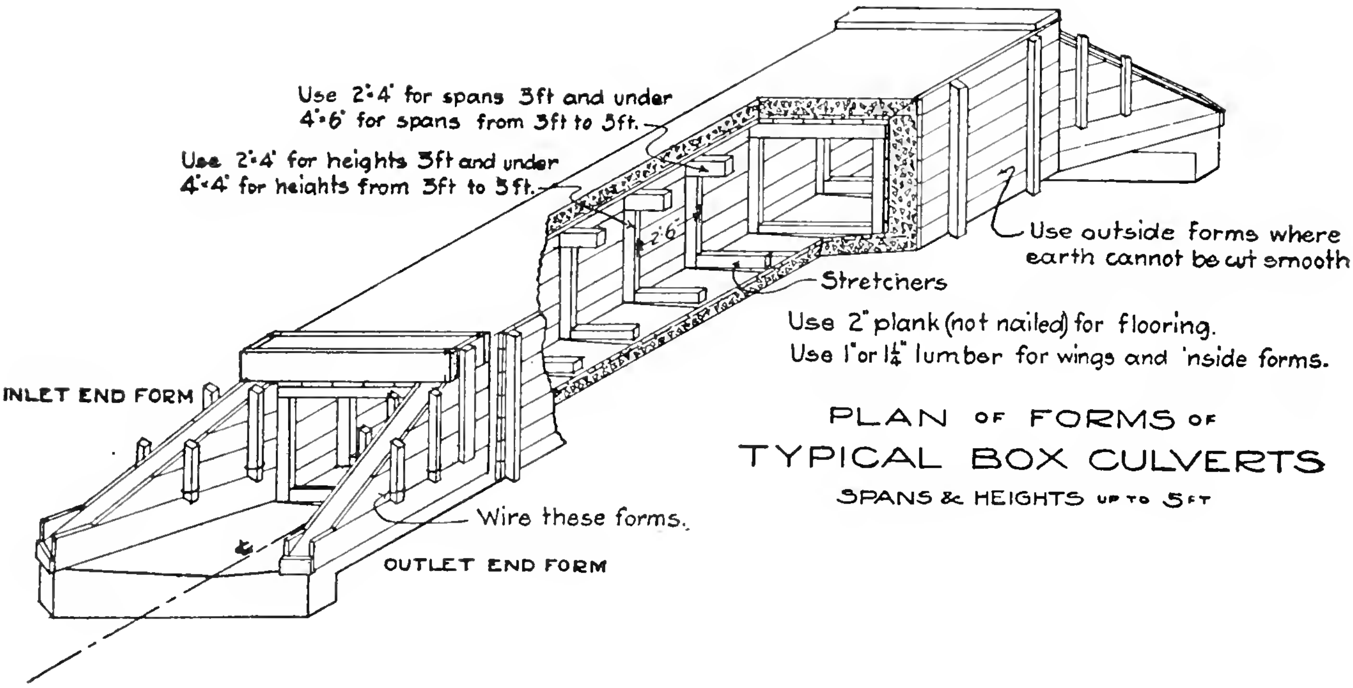
The cost of moving the plant from one job to another will usually be from $10 to $20, where the plant is not moved over five miles.

The cost data below is for a small 4 x 5 box culvert 26 feet long, built according to the designs in this bulletin and illustrated in Plate VIII.

The work was done by a regular county concrete gang, composed of a foreman seven men and two teams with drivers, and was completed in four days of 10 hours each. The excavation was light, but the soil was of a hard, black nature that was hard trimming. Water for mixing had to be hauled two miles.

Material (laid down at culvert).

Cement, 26 bbls. at $1.80	$ 46.80
Hauling cement, 12½ hrs. at 30c.	3.75
Gravel, 18½ cu. yds. at $1.10 f.o.b. cars Ennis, Texas	20.35
Hauling, 18½ cu. yds., 46 hrs., at 30c. (75c. per cu. yd.)	13.80
Steel, 1,072 lbs. at 2½c.	26.80
Hauling steel, 2 hrs. at 30c.	.60
Lumber, 1,000 ft. B.M. at $25	25.00
Hauling lumber, 3 hrs. at 30c.	.90
	$138.00
75% salvage on form lumber	18.75
Total cost of material at job	$119.25
Total cost of job	$180.45



PLAN OF FORMS OF
TYPICAL BOX CULVERTS
SPANS & HEIGHTS UP TO 5 FT

Sand gravel was used for aggregate in the concrete. The gravel contained a slight excess of sand and worked up in proportions given. Mixing was done by hand with negro labor. Twisted square steel bars were used for reinforcing.

Labor.

Foreman, 40 hrs. at 25c.	$10.00
Culvert excavation, 9 cu. yds. at 80c.	7.20
Labor on forms	14.00
Mixing and placing, 120 hrs. at 15c.	18.00
Hauling water, 20 hrs. at 30c.	6.00
Cutting and placing steel, 10 hrs. at 15c.	1.50
Cleaning up and removing forms, 10 hrs. at 15c.	1.50
	$58.20
50% salvage on form lumber	7.00
	$51.20
Moving on and off job	10.00
Total labor at culvert	$61.20

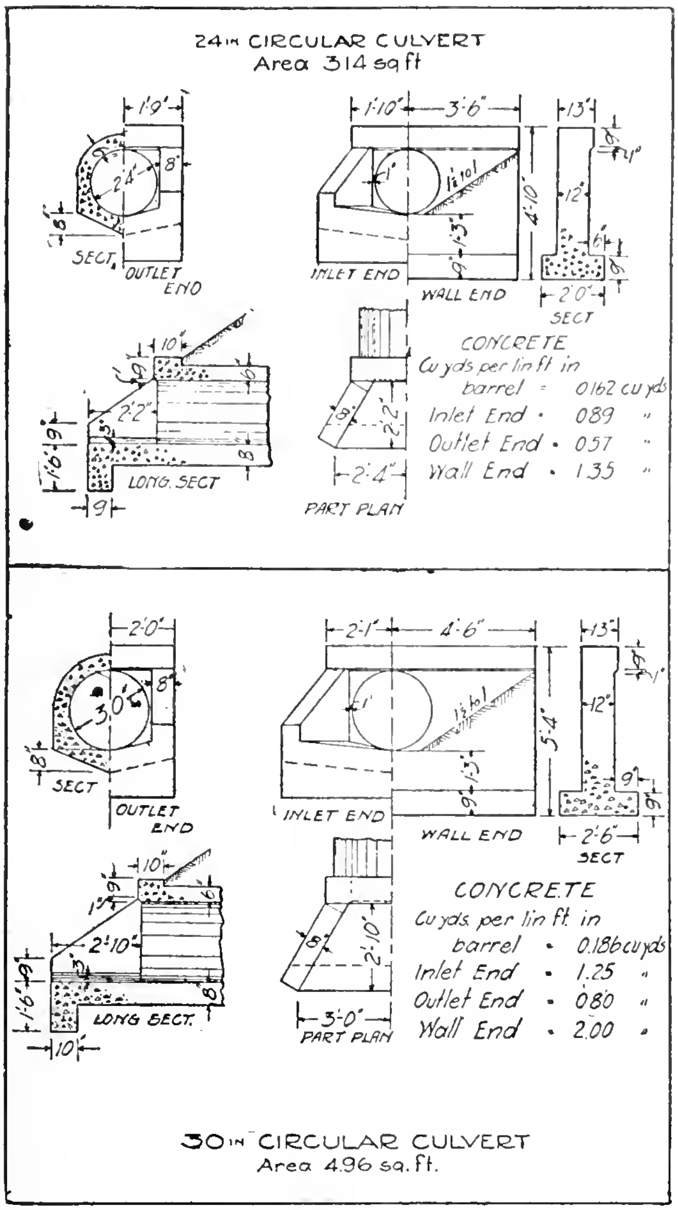
Cost per cu. yd. of concrete in place exclusive of culvert excavation	$ 9.37
Cost per cu. yd. of concrete in place exclusive of excavation and steel	7.85

The quantities were as follows: 14½ cu. yds. of 1:3:5 concrete; 4 cu. yds. of 1:2½:4 concrete; 432 lbs of ¾ in. steel; 640 lbs. of ½ in. steel; and 1,000 ft. B.M. of lumber.

In estimating the cost of work it is well to use a form similar to that shown for the cost data above. When it is desired to find the probable cost per cubic yard of concrete, Table VII. is convenient. The various amounts of each material are determined and multiplied by their cost per cubic yard laid down at the job, these costs varying for almost every case. The other costs which are more nearly constant may then be added as shown below.

For example, if 30 cu. yds. of 1:2½:5 concrete is needed and the cost of material laid down at the job is as given, its cost per cubic yard may be approximately estimated as follows:

Cement, 1.37 bbls. at $1.50		$2.06
Sand, 0.48 cu. yd. at $0.50		.24
Stone, 0.96 cu. yd. at $0.50 to $1.50	$0.50 to	1.45
Mixing and placing		1.00
Forms (labor and material)	.50 to	.75
Hauling material	.50 to	3.00
Foreman, moving, cleaning up, etc.		1.00
Plain concrete (per cubic yard)	$5.85 to	$9.50
Reinforcing steel (0.5% to 0.8%), 66 to 106 pounds at 3c. per pound in place	2.00 to	3.20
Reinforced concrete per cubic yard	$7.85 to	$12.70



It will be seen that the cost of hauling and the cost of stone or gravel will greatly influence the cost of the concrete.

Westinghouse, Church, Kerr and Company, are now in their new offices at Wall Street, New York City.

An issue of *The Canadian Engineer* for March the 28th, 1912, is desired. Subscriber sending in same will have subscription extended one month.

CONSTRUCTION WORK IN REGINA.

(Staff Correspondence.)

The much-talked-of money stringency does not [illegible] to have had any great effect on building operations in Regina. Arrangements are being made for the early construction of the proposed new power house which will be situated on the banks of the Wascana Lake, and will cost about $425,000.

The library board is urging the city council to erect two new libraries—one in the northwest section of the city, and the other in the east end. So far the city council has looked with favor on the proposition.

The Parsons Construction Company have just completed the outside work on the Connaught School, and expect to have the remainder of the work finished in time for the occupation of the school by September 1, the commencement of the fall term. This school will contain 22 rooms and will contain equipment for manual training and domestic science in addition to the regular class-rooms.

The Regina College will erect this year: (a) Two towers on top of the present college building at a cost of $80,000; (b) a ladies' college and residence, funds for which have been provided for out of the Massey estate, at a cost of $100,000; (c) a boy's residence to cost $100,000.

The Anglican church also has an ambitious programme on hand, the most important of which is the St. Chad's College and Synod House. The college will be three stories and basement, and will be built of pressed brick and terra cotta trimmings, in the Gothic style of architecture. The main building of the college will be 175 feet by 60 feet. There will also be a chapel of the dimensions of 62 feet by 24 feet. The total cost will be about $100,000. The Synod House will be two stories and basement, built of the same material and same style of architecture as the college. The cost will be about $7,000.

It is expected that construction work will be commenced on the proposed new armories within the immediate future. The cost of the buildings is to be in the neighborhood of $250,000. There will be a full-sized basement and the area covered by the entire building will be 145 feet by 275 feet. The construction will be clinker brick. Arrangements will be made for a drill hall, club rooms, store rooms, bowling alleys, shooting galleries, officers' quarters, etc.

Architect Fortin is now busily engaged on the preparation of plans for the new Roman Catholic bishop's palace, which it is estimated will cost in the neighborhood of $50,000.

One of the best warehouses to be erected in Regina during the present year will be that of the British Columbia Sugar Refinery. The contract for the erection of this building has already been let. It will have ground dimensions of 150 feet by 113 feet, and will be of brick construction.

The house problem, which was a very vexatious one at the commencement of the spring season, has now been practically solved. The private firms doing business in the city have worked together well with this end in view, and the result has been that various firms have erected houses in groups varying from six to one hundred. The result has been that plenty of accommodation has now been made possible. The building of dwellings, however, continues to go steadily ahead, in order that the hundreds of newcomers who arrive weekly may be accommodated. Some of those who have taken out permits for houses, and the number of houses are named below: Seven houses on Montague Street for T. Davidson; five houses on Montague Street for Grant & Lounsborough; 20 houses in Lakeview; 34 houses in Eastview and Eastern Annex by J. K. McInnis & Sons; three

houses in Rosemont by G. W. Sloan; 20 houses in Parliament Heights by Fraser and Keenleyside. The houses being erected by Fraser and Keenleyside will cost from $4,000 to $6,000 each and will be for rent.

Many high-class dwellings will be erected in Lakeview sub-division this year. Messrs. McCallum, Hill & Company have sold considerable of the property fronting on Albert Street at $80 per foot frontage. The lots so sold have not had a frontage of less than 80 feet and in some instances 100 feet. It is stipulated that the purchaser in each case erect a dwelling to cost at least $8,000, work on which must commence within two months. McCallum, Hill & Company estimate that the total value of dwellings to be erected on the $27,000 of this property sold within the past four days is $85,000 at least.

Dr. Andrews has requested the city council to allow him to try his new style of paving which, according to his statement, costs only a fraction of the cost of ordinary pavement. Dr. Andrews only asks a royalty of one cent per square yard, above actual cost price. Arrangements have been made for Dr. Andrews to meet the civic works committee before the contracts for paving are let.

Mayor Martin has been instructed officially by M. Donaldson of the G.T.P. Railway Company, that the work of constructing the $1,000,000 hotel "The QuAppelle" will be commenced immediately, the contract having already been let.

Howell, Smith & Company have announced their intention of erecting 50 houses of from six to eight rooms each, in the C.P.R. annex, providing the city will agree to extend the sewer and water mains to serve the property.

Balfour, Broadfoot Company have also announced their intention of erecting a number of high-class dwellings in Belvedere. Work will likely be commenced on them within the course of the next week or two.

Fordyce & MacNeil have announced that they will erect a $25,000 apartment block in Parliament Heights.

The police commission of Regina has turned down the plans for the police station prepared by Architect Fulton, and which were accepted by last year's commission. Competitive plans are being called for. Architect Fulton will be paid, however, for his work.

CANADA'S CANAL TRAFFIC.

The total quantity of freight passed through the several divisions of the Canadian canal system during the season of 1912 is as follows:—

——	Farm Stock	Forest Produce of Wood	Manufactures	Products of Mines	Agricultural Products	Total
	Tons	Tons	Tons	Tons	Tons	Tons
Sault Ste. Marie.	372	54,114	975,303	34 109,074	4,530,792	39,669,655
Welland..	678	227,684	625,569	797,072	1,205,912	2,851,915
St. Lawrence......	9,375	578,760	464,091	1,305,395	1,119,567	3,477,188
Chambly..........	338	425,313	11,600	161,458	19,706	618,415
St. Peter's.......	2 996	11,161	7,583	37,642	15,427	74,809
Murray.	37	706	101,511	67,379	448	170,081
Ottawa.	2,880	226,600	20,958	136,634	5,278	392,350
Rideau.........	3,151	28,642	18,814	105,531	3,995	160,133
Trent.	361	67,489	3,459	3,327	2,514	77,150
St. Andrew's......	......	14,153	60	81,299	37	95,549

The total quantity of freight moved on the Welland Canal was 2,851,915 tons, of which 1,205,912 tons were agricultural products.

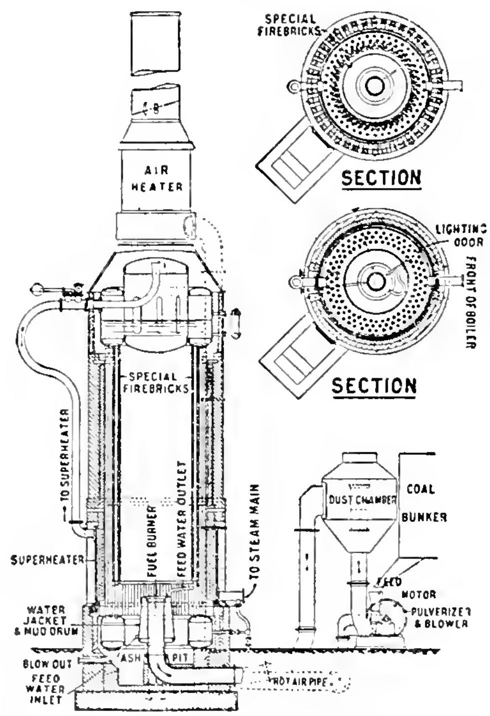
On the St. Lawrence canals the total quantity of freight moved was 3,477,188 tons, of which 1,119,567 were agricultural products, and 464,091 tons were manufactures.

On the Ottawa canals the total quantity of freight moved was 392,350 tons; of this quantity 226,600 tons were the produce of the forest.

THE BETTINGTON DUST-FUEL BOILER.

In these days, when the question of fuel occupies the minds of so many engineers and others interested in the generation and transmission of power, the following description of the Bettington boiler, gathered from a paper read by H. V. Hart before the Manchester Geological and Mining Society, will be of interest:—

It has long been known that an almost perfect combustion can be obtained by the introduction of finely pulverized coal, with a correct proportion of air, into a heated furnace. Attempts have been made in the past to burn dust by blowing it into the furnaces of Lancashire boilers, but it was found that the flues soon became filled up with partly consumed dust, and that the output of the boiler was consequently reduced. Other methods have been tried, but it has been found impossible to keep intact the brickwork with which the furnace is surrounded. Up to the present, therefore, the use of pulverized fuel was limited to the burning of cement in special kilns, no commercial success having been established in its use for firing boilers. A plant that has successfully overcome these difficulties has been erected at the Outwood Collieries, near Manchester, as herein described.



SECTIONAL VIEWS OF BETTINGTON BOILER

A complete system of dust collection has been installed A fan, 25 inches in diameter, running at 680 revolutions per minute, and driven by a 12 horse-power motor, produces the suction required, and delivers the coal dust into a large cyclone collector some 20 feet high and 10 feet in diameter. The air and dust enter the collector at the side, and, the air being made to revolve, the dust separates and descends by gravity to the bottom of the cone, while the air is expelled at the top. Galvanized iron pipes of suitable diameter for carrying the dust are led from the tipplers, screen, collecting-belt, railway waggons, and bunker; two sweep-ups are also provided at the ground level. The coal dust is drawn off the collectors into colliery tubs, and deposited by means of a creeper and a hoist into the bunkers of the dust-fuel boiler.

The Bettington boiler is the outcome of many experiments made in America and South Africa, and was designed primarily for burning low-grade fuels in those countries The boiler is constructed for a working pressure of 160

pounds per square inch, and to superheat the steam by 110 degrees Fahrenheit. It is of the vertical multitubular type, consisting of a bottom and a top heater, supported by three rows of tubes, 3¼ inches in diameter, and so designed that expansion can take place without straining the boiler, the air-heater and chimney being supported on brickwork independent of the boiler structure.

The boiler is fired by a central tuyere, or gas-jet, 14 inches in diameter. This tuyere is water-jacketed, and cooled by the feed-water, which is led by a special tube from the jacket to the top-header. The steam passes out from this top-header in a saturated state, and is led down to the superheater. The superheater is made up of a series of horizontal tubes which pass round the boiler, between the brickwork and the outer row of vertical tubes, the steam finally leaving the boiler at this level.

The fuel is led from the bunker, by means of a worm, into an electrically-driven pulverizer, running at 1,500 revolutions per minute. The pulverizer consists of a number of manganese-steel blades, or beaters, revolving in a casing lined with steel liners. These beaters grind up the coarser particles of coal, and constitute a fan which produces the necessary draught for forcing the dust into the furnace. Two slides are provided on each side of the casing for varying the amount of air required for combustion. Air is also drawn from the air-heater situated in the chimney stack, the coal-feed being regulated by a variable speed device fitted on the worm-shaft. The coal-dust is then forced, together with a correct proportion of air, into a separator; the fine dust is blown through a gauze, the larger particles falling down to be repulverized.

It is found that, owing to friction and expansion, the air soon loses its initial velocity, but that the particles of coaldust continue in their upward direction until they strike the top of the furnace, where, owing to gravity, and to the fact that they are cooled by striking the under side of the top-header, they descend, and, in exceeding the velocity of the air, become completely oxidized.

The size of the dust particles is, therefore, limited to that which can be completely consumed in the time occupied on the journey up and down the furnace; and it has been found in practice that this furnace will consume coarser particles of coal than any other which has hitherto been constructed for burning pulverized fuel.

The ash in the fuel, during its passage through the furnace, is converted into a liquid spray, the greater portion of which strikes the brickwork, and fills up the crevices. In lining the furnace, therefore, it is only necessary to build up the bricks by placing them one upon another, no fire-clay being needed; in fact, after a few weeks' working the interior will present a glazed appearance, forming one solid mass, and thus protecting the first row of tubes from the flames.

The internal face of the brickwork always remains in a semimolten state, forming a reserve of radiant heat, ready to be transformed into steam at a moment's notice, should there be a sudden demand.

This boiler compares very favorably in upkeep with any other boiler fitted with a mechanical stoker. It is found to be practically smokeless in operation, as only a film of grey dust is emitted from the stack.

The initial cost of the boiler is not heavy, when it is understood that neither economizer nor chimney-stack is needed; and the writer is of the opinion that in the larger sizes, it would not be more expensive in first-cost than other makes.

The advantages of this type of boiler may be summed up as follows: (1) High thermal efficiency, (2) smokeless combustion, (3) quick steaming, (4) flexibility in output, (5) small ground-space required, (6) no banked fires, (7) low radiation losses, and (8) the use of low-grade fuels.

INITIAL STRESSES IN STRUCTURAL STEEL.

By Joseph R. Worcester.

The subject of initial stresses in rolled members has received much attention in recent years, but no more than it deserves, for the reason that, under certain circumstances, it may result in very serious consequences.

A few years ago much attention was attached to a series of tests by Prof. Edgar Marburg, of the University of Pennsylvania (Proc. Am. Soc. Test. Mat., Vol. IX.), on I-beams of standard section and certain Bethlehem shapes, on account of the extremely low elastic limits reported. The cause of these low results was undoubtedly the initial stress near the junction of web and flange, produced by different rates of cooling of thick and thin metal.

More recently experiments by James E. Howard (Trans. Am. Soc. C.E., Vol. LXXIII.) and Professors Talbot and Moore, of the University of Illinois (Bulletin 44), have developed strikingly an early lack of proportionality of stress and strain in built-up columns, which can only be explained by internal initial stresses.

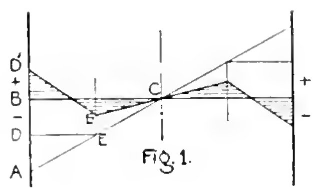


Fig. 1.

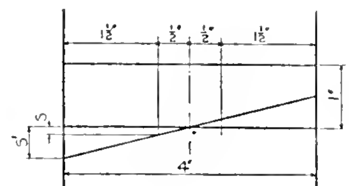


Fig. 2.

Another striking example of internal stress which has been known to many members of this Society has been in large I-beams which have suddenly, without provocation, split through a large part or the whole length of the web.

For many years it has been recognized that where steel is heated locally for forging there is likely to be produced a region between the heated and unheated portion where the metal is brittle and can be broken by a blow or shock. A striking instance of this came under the speaker's observation recently in the case of some 2-in. diameter steel truss rods which had been upset. One of these, in unloading from a team, had its upset end broken short off with a granular fracture. On testing the other rods, by striking the end with a sledge, it was found that several broke in the same way, while the rest could not be broken. A chemical analysis of one of the worst ends showed 0.408 per cent. C., 0.045 per cent. S., 0.065 per cent. P., 0.38 per cent. Mn., a result consistent with good metal. Though perhaps not so certainly established as other cases, it is quite probable that this fracture was induced by internal stresses caused by the local heating.

A similar effect in eyebars was noticed, soon after the introduction of steel into their manufacture, and led to the universal adoption of annealing furnaces long enough to anneal the whole bar at one time after forging. This practice has recently been proved by Mr. A. H. Emery to be of no benefit, as far as can be determined by tensile tests, as it decreases both the elastic limit and the ultimate strength, while no decrease in strength appears to follow from the local heat treatment, under direct tension as applied in the testing machine. It does not necessarily follow, however, that the annealing may not be a desirable precaution as a safeguard against shock.

Admitting, then, the prevalence of initial stresses, it is interesting to consider their origin with a view to guarding

* Presented before the Association of Engineering Societies.

against them where possible. When their origin is in some form of heat treatment, it is generally possible to overcome them by annealing, though this may not be the only or the best method.

When they are confined to members used in direct tension they may not be of serious import, because, on the application of stress to the member, the effect is to increase the initial tensile stresses already existing, reducing or neutralizing internal compressive stresses. As the applied load increases, a point is soon reached where the fibres carrying most of the tension reach the elastic limit and begin to stretch, after which a redistribution of stress occurs, spreading the stress over all the fibres equally.

A familiar example of this is in the case of a copper wire which may be coiled or crooked with internal stresses. We all know how if such a wire is stretched beyond the elastic limit all crooks immediately disappear. So with a steel member, if in tension it is in stable equilibrium, and a minute stretch can usually occur without harm to the structure.

With compression members, however, the case is radically different. In these, the first applied load, if initial conflicting stresses exist, tends to throw the whole member out of alignment. It is in unstable equilibrium, and the more it bows, the greater the danger.

One of the causes of initial stresses is cold straightening of metal before assembling. Cold straightening is, in reality, cold bending, and the following investigation is an attempt to determine the limits of internal stress which may be produced by cold bending.

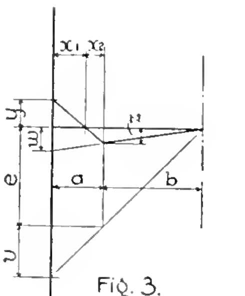


Fig. 3.

$$x_1 + x_2 = a \qquad [1]$$

$$\frac{x_1}{y} = \frac{x_2}{z} \qquad [2]$$

$$y + e = v + e - w \qquad [3]$$

$$\frac{v+e}{e} = \frac{a+b}{b} \qquad [4]$$

$$\frac{w}{z} = \frac{a+b}{b} \qquad [5]$$

$$y\frac{x_1}{2}\left(a+b-\frac{x_1}{3}\right) = (b+x_2)\frac{z}{2}\left(\frac{b+x_2+b}{2}\right)\frac{2}{3} \qquad [6]$$

Solving these equations, we obtain these values for y & z in terms of a, b & e:—

$$y = \frac{a(a+2b)}{2(a+b)^2}\,e \qquad z = \frac{a^2(2a+3b)}{2(a+b)^3}\,e\,.$$

It is well known that the material as it comes from the hot bed is almost always more or less out of line, and that in order to straighten it the most effective and simple method, and the one generally used, it to bend the member, in the direction opposite the initial curvature, enough so that when it springs back under its elasticity its alignment will be true. The effect of this bending beyond the straight line and allowing the elasticity to recover it to the correct point is to strain the outer fibres on each side beyond the elastic limit. The elastic recovery reverses the stress in the extreme fibres which have been overstraind, and leaves a condition of stress within the section something as shown by the diagram on the foregoing page.

This means that starting from one edge of the section we find at first a tensile fibre stress extending in a certain distance in constantly decreasing intensity until it reaches a point of no stress or a secondary neutral axis, beyond which the stress becomes compressive, increasing to a maximum at a point, the distance of which from the outer fibre is the same as that which limited the field of metal stressed above the elastic limit by the bending. From this point the compressive stress diminishes to the axis of the section, beyond which it becomes tensile again, increasing to a certain point from which it decreases again, again changing to compression at another secondary neutral axis and increasing in compressive stress until the opposite extreme fibre is reached.

In considering Fig 1, we see at once that with a symmetrical rectangular section we have two fields of tensile stresses and two fields of compressive stresses represented by triangles, and we find that certain assumptions may be made with regard to these fields which serve to fix their amounts.

In the first place, considering the effect of the bending, if the material was not strained beyond the elastic limit, the stresses on each side of the neutral axis would have been re-

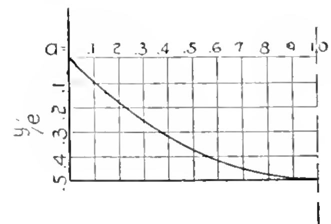


Fig. 4.

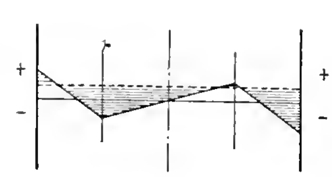


Fig. 5.

presented by a single triangle ABC. If, however, the stress AB is greater than the elastic limit of the metal, this triangle would be truncated by a line DE parallel to the cross section and distant from it an amount represented by the elastic limit of the material. When the bending stress is relieved, the line DEC assumes a new position D′E′C, the distance from D to D′ and from E to E′ being proportional to the distance from the neutral axis. This proportionality is one of the determining elements. Another is the fact that the total tensile stress multiplied by the distance of its centre of gravity from the neutral axis must equal the compressive stress multiplied by its axial distance. This is a necessary condition of equilibrium.

Lest it should be argued that the line DEC does not agree with the stress-strain diagram it should be borne in mind that in considering the elastic distortion we are dealing with an extremely minute deformation. Between adjacent planes of cross-section it is really infinitesimal, and any finite stretch would be so small as to produce practically no increment in stress. This consideration is valueless on account of its imaginary character. We might, therefore, without invalidating the argument, assume that we are considering the angle between two planes of cross-section separated by a finite distance, as, for instance, one inch.

Suppose, for example, a bar 4-in. by 1-in. bent edgewise, to a radius of curvature such that one quarter of its width along the neutral axis is still elastic and the balance, on each side, overstrained.

Referring to Fig. 2, the stretch S, at the limit of the elastic portion, will be about:

$$\frac{30{,}000}{30{,}000{,}000} = \frac{1}{1{,}000} \text{ inch.}$$

The stretch of the extreme fibre S′ will be:

$$0.001 \times \frac{1.5}{5} = 0.003.$$

The assumption is that the elongation of S′—S will not cause an appreciable increase in stress after the metal has reached the elastic limit.

$$S' - S = 0.003 - 0.001 = 0.002 = \frac{2}{10} \text{ per cent.}$$

If the gain in strength between the elastic limit and the ultimate is accompanied as it frequently is, with a stretch of 30 per cent., and we should assume the rate of gain propor-

tional, this stretch of 0.2 per cent. would mean an increase of stress of about

$$\frac{0.2}{30.0} \times 30{,}000 = 200 \text{ lb.}$$

But, the characteristic of stress-strain diagrams is that there is a sudden yielding accompanied by a very considerable stretch with no increase in stress or even a slight falling off. To be sure, in assuming any sharp angle in the diagram, there is a slight error, as the corner should be rounded. It would be more exact to say that the lines assumed are tangent to the curves, but the effect of this rounding may be disregarded without invalidating the theory. Referring to Fig. 3, the above assumptions may be expressed algebraically as follows:

Letting $a+b=1$, we find that the equation for y assuming a as a variable is a parabola with its vertex at the neutral axis of the section of ½e, the parabola passing through the origin. This equation is $y = \left(a - \frac{a^2}{2}\right)e$, or $2a - a^2 = \frac{2y}{e}$.

Expressing this result in words, it amounts to this: If a rectangular bar is bent so that it has any permanent set the internal maximum fibre stress may be obtained if we know to how great depth the outside portion of the section has been stressed beyond the elastic limit. The amount of this internal stress can never exceed one half the elastic limit, and between 0 and ½ e it varies according to the abscissas of a parabola of which the axis is the neutral axis of the section.

We may determine the depth to which fibres are stressed beyond the elastic limit, if we know the radius of curvature and the thickness or depth of the section. We know from mechanics that $\frac{1}{r} = \frac{e}{Ed}$, in which r is radius of curvature, e is elastic limit of the material, E is the modulus of elasticity and d is distance from the neutral axis to the extreme fibre. Using 30,000 for e and 30,000,000 for E, this formula becomes $r = 1{,}000d$. In other words, the distance from the neutral axis to the fibre which is strained just to the elastic limit will be one thousandth of the radius of curvature; hence, if we know approximately the radius of curvature, we can tell at once what part of the thickness of the section is not overstressed, and, subtracting this from one half the total thickness, can find a. Taking a practical example of this we should obtain the following results.

Assume a bar 3-in. by 1-in. to be somewhat crooked edgeways and to be straightened in a press. Let us assume that in straightening it is curved to a radius of 12 ft., a very moderate assumption.

The width of metal not overstressed would be $\frac{12 \times 12}{1{,}000} =$ 0.144 in. each side of the neutral axis.

$$a \text{ would therefore} = 1.5 - 0.144.$$
$$= 1.356 \text{ in.}$$

or, on the basis of $a+b=1$.

$$a = \frac{1.356}{1.5} \times 1 = 0.9.$$

From the diagram, Fig. 4, we find that under these circumstances y, the initial fibre stress, amounts to 0.495 e, tension on one edge, and compression on the other, or approximately to 15,000 lb. per sq. in.

This means that in a bar which is quite straight and wholly innocent in appearance there may exist a compressive stress along one edge of 15,000 lb. per sq. in., while along the opposite edge is a tensile fibre stress of an equal amount; in other words, an inherent tendency to bend out of line on the least provocation. This condition cannot be detected by any of the usual methods of inspection, but might be suspected if we knew its history.

It will be noted that the above analysis applies only to a rectangular section. In the case of an irregular section such as an I-Beam, it is evident that if the bending is in the plane of the web, a lesser stress in the extreme fibre will produce equilibrium on account of the decreased area of the section in the parts nearer the neutral axis. On the other hand, however, if the bending is at right angles to the web, the converse is true, and the extreme fibre stress will be greater proportionally, and may easily approach nearer to the elastic limit. The same is true of a bar with a circular cross section.

Let us now consider the practical effect of these internal stresses. Referring again to Fig. 1, we see that if we apply an axial stress to a member which is already subjected to this condition of internal stress the effect will be to produce a condition as shown by Fig. 5

In this case we see at once that the areas of stress will be unbalanced so far as the rotating moment is concerned. The effect of this unbalanced condition will be to produce a tendency to spring out of line. If the axial stress is in tension, this tendency is offset by the axial stress itself, and even in case the extreme fibre stress exceeds the elastic limit, a slight yielding of these fibres soon distributes the stress more uniformly and so no serious results can occur. But if the axial stress is compressive, the tendency to spring is very serious and immediately throws the strut out of equilibrium, so that the bad effect of the internal fibre stress is accentuated. If the elastic limit is passed, the buckling may even go on to the point of failure.

It is not the present purpose to enlarge upon applications of the above theoretical considerations, but perhaps enough has been said to show the tremendous importance of eliminating cold straightening so far as possible from the ship treatment of metal which goes into compression members.

A copy of telephone statistics of the Dominion of Canada just issued shows that the total number of telephones in service in Canada is 370,884, 212,732 common battery and 158,152 magneto. During 1912 there was an increase of 37,738 in the number of telephones operated by common battery, and an increase of 30,387 in the number operated by magneto. The total number of miles of wire is given as 889,572. This is divided into urban and rural as follows: Urban, 636,961; rural, 252,610. This indicates that there is one mile of telephone wire in use for every 8.1 of the total population of the Dominion, and one telephone for every 19.3. There was one telephone for every 2.3 miles of wire. The class of wire used was as follows: Galvanized, 271,191 miles; copper, 20,096; overhead cable, 232,393; underground cable, 364,875; submarine cable, 1,015. The aggregate capital expenditure in telephones is now placed at $46,276,851, though the cost of real property is placed at something over $10,000,000 beyond this figure. This works out to a capitalization of $124.75 per telephone in use. The gross earnings from all telephone companies for the year amounted to about $12,250,000, as compared with a little over $10,000,000 the previous year. Operating expenses were 74.0 per cent. of gross earnings as compared with 69.32 for the previous year. Gross earnings work out to $33.90 per telephone in use or $13.79 per mile of wire.

THE RECLAMATION OF SWAMP AND OVERFLOW LANDS.

Mr. E. T. Perkins, of the National Drainage Congress of the United States, gives an argument for national direction for swamps and overflow lands in the Journal of the Western Society for Engineers for February, 1913. A summary of the argument is as follows:—

The national problem of controlling and regulating the Mississippi, is only a part of the problem of our swamp and overflowed land of approximately 74,000,000 acres lying in almost every state in the Union. The vast benefits to be derived from the reclamation of this great area are too obvious to require comment. It is generally known that these acres possess wonderfully fertile soil, capable of producing great crops for many years without defertilization to any marked degree.

The United States Department of Agriculture touched on this subject in Circular No. 76, Office of Experiment Stations, on "Swamp and Overflowed Lands in the United States," issued in 1907. The circular (basing the acreage to be reclaimed at 77,000,000) states:

In those states where large areas of swamp land have been thoroughly drained by open ditches and tile drains, the cost ranges from $6 to $20 per acre, while in places where tile drainage was not required the average cost has not exceeded $4 per acre. Judging from the prices which prevail in a large number of these districts where work of this kind is being carried on, it is safe to estimate that the 77,000,000 acres of swamp can be thoroughly drained and made fit for cultivation at an average cost of $15 per acre. The market value of these lands in their present shape ranges from $2 to $20 per acre, with an average of probably $8 per acre. Similar lands in different sections of the country that have been drained sell readily at $60 to $100 per acre at the completion of the work, and in many instances, when situated near large cities, they have sold as high as $400 per acre. To determine whether or not it will pay to drain these lands, we have but to consider the following figures:

Cash value of 77,000,000 acres after thorough drainage, at $60 per acre		$4,620,000,000
Present value of this land at $8 per acre	$ 616,000,000	
Cost of drainage at $15 per acre	1,155,000,000	
Value of land and cost of draining		1,771,000,000
Net increase in value		$2,849,000,000

These figures, though large, are not fanciful, but are based on results obtained in actual practice in different sections of the country where work of this kind has been done.

Since this circular was issued by the Department of Agriculture in 1907 many swamp and overflow acres have been reclaimed; the cost of reclamation undoubtedly has risen with the general increase in cost of things, but the value of the land also has risen, so it may be conservatively supposed that the net result as figured in 1907 is approximately the proper figure for to-day, upon the assumption that 100 per cent. of these lands could be reclaimed, which of course we know to be impossible.

Now, the reclamation of the great bulk of swamp and overflowed acres is largely dependent upon the control and regulation of the nearest main river system and its tributaries.

From the headwaters to the mouth it is not possible to reclaim or correct one part without at the same time exerting some influence, either for good or bad, upon the other portions.

This is a natural fact. When we try to subdivide one of the problems and solve each subdivision from our own limited viewpoint, and for our personal, selfish interests, we are making trouble for ourselves or someone else, or both. We are doing more; we are violating the laws of Nature which, before the arrival of man, establishel these drainage basins, and provided these drainage problems for us to solve. There is only one right solution to every problem; there may be found ways to find many answers, but only one of these can possible be the best.

Can we establish arbitrary boundaries, often in ignorance of existing physical conditions, ignoring natural problems and necessities, and say: "Here, this political body shall have jurisdiction, and there, that one?"

Physical, economic, social reasons demand that the reclamation of these 75,000,000 acres of swamp and overflowed lands, and the control of the waters that cause them, must be undertaken in a broad and comprehensive way—in a national way—and this cannot be done offhand.

There is no cure-all, no panacea. Careful investigation and study must be had that there may be developed a plan founded upon justice, equity, and good engineering. It must be constitutional, not only as regards the nation but as regards each state affected. In addition, every beneficiary, nation, state, corporation, individual, must in due proportion bear the expense of the improvement producing that benefit, either direct or indirect. With the insufficient data available I would hesitate to accept or reject at this time any particular plan.

But how shall we put into effect this general plan after we shall have formulated it?

The several states were granted all swamp and overflowed lands remaining unsold within their borders after September 28, 1850, for the specific purpose that the proceeds of their sale should be used in reclaiming them. So far as I know, Florida is the only state that is complying with the provision of the act, and except in Florida, practically all of these swamp lands have passed into private ownership in lots ranging from a few acres to many thousands, with the owners scattered about the world.

This condition of ownership is one of the difficulties that must be contended with. The Reclamation Act was designed to reclaim the federal lands of the West, and when private holdings were taken into a project it was by mutual consent and on a partnership basis. The government brings the water to the land after a certain percentage of the land owners in the project have agreed to join in its reclamation. No one is compelled to accept the use and benefit of this water if he has not so agreed, nor is he apt to be benefitted individually unless he does pay.

In the case of swamp and overflowed lands, however, it is not practical to drain or levee part of the land without affecting the rest; each tract of land will be benefited whether the owner desires such benefit or not, or whether he wants to pay his share of the cost of reclamation. For this reason most of the states containing swamp and overflowed lands have passed drainage laws allowing certain majorities either of lands or owners, to form drainage districts and so compel all persons owning lands within the district that may be benefited, to help pay the costs of reclamation.

Just as the states can help the individual land owners to organize their drainage districts, so can the federal government, in planning a complete system covering the entire drainage basin, by means of complete surveys and plans, work out efficient and harmonious plans for each individual

project, if desired, and have each individual project harmonize with the general plan covering the entire drainage basin. This, I hold, is a national duty and a national necessity.

TYPHOID FEVER IN PITTSBURGH.

Before the installation of the water filtration works Pittsburgh had a typhoid fever death rate of practically double that of any other large American city. As set forth in the last report of Mr. C. A. Drake, superintendent of filtration, the first filter unit was started in December, 1907. All of peninsular Pittsburgh was receiving filtered water exclusively in October, 1908, and all of the south side, except the 20th ward, in February, 1909. The present typhoid fever death rate in the filtered water district shows that the purified water supply may well be included among the very safest supplies of the world.

The following table, showing typhoid fever statistics in certain important American cities, shows what the Pittsburgh filtration works, under skilled supervision, and with the final filtered product sterilized with hypochlorite of lime, has done in the line of cutting the typhoid fever death rate to a practical minimum. The results achieved at Pittsburgh in this line are by far the most gratifying and spectacular ever noted in the history of water purification in this country.

Typhoid Fever Death Rate in Certain American Cities.
(Death Rate per 100,000 Population.)

CITY	1906	1907	1908	1909	1910	1911	Supply Filtered or Unfiltered
Albany	20	20	11	19	15	15	Filtered
Atlanta	50	64	47	44	43	56	Filtered
Baltimore	34	41	31	23	41	26	Unfiltered
Boston	22	10	26	14	11	9	Unfiltered
Buffalo	24	29	21	23	20	25	Unfiltered
Chicago	18	18	15	12	14	10	Unfiltered
Cincinnati	71	46	19	13	6	11	Filtered
Cleveland	20	19	13	12	19	14	Unfiltered
Denver	68	67	58	24	30	18	Unfiltered
Indianapolis	39	29	26	22	31	23	Filtered
Kansas City	38	40	35	23	38	24	Unfiltered
Milwaukee	31	26	17	21	45	19	Unfiltered
Minneapolis	35	26	18	20	58	11	Unfiltered
Nashville	66	85	62	53	48	..	Unfiltered
New Orleans	30	56	31	25	28	25	Filtered
New York	15	17	12	12	12	10	Unfiltered
Omaha	28	24	22	31	75	18	Unfiltered
Philadelphia	74	60	36	22	17	13	Filtered
Richmond	44	41	50	24	22	18	Unfiltered
Washington	52	36	39	33	23	20	Filtered
*Pittsburgh	141	135	53	13	12	10	Filtered

* Filtered water district. Includes 410,000 of a total of 545,000 inhabitants of Pittsburgh.

The National Pipe and Foundry Company, Limited, whose head office was formerly in the Board of Trade Building, Montreal, has moved to larger quarters at 802 McGill Building, McGill and Notre Dame Streets, Montreal. The company's works are at Alexandria, Ontario, where they make tanks and wooden water pipe in all sizes from 2-inch to 24-inch for waterworks systems, domestic supply and hydraulic mining; insulated wire conduits, steam pipe casings and acid-proof pipe for mines, tanneries and pulp mills.

COAST TO COAST.

Halifax, N.S.—The completion of the three transcontinental railway systems by providing what they lack—a properly equipped Atlantic terminus—is the central idea of the Dominion government in spending twelve million dollars on new terminals at Halifax, contracts for which, it is expected, will be let shortly. Halifax thus becomes one of two great winter ports of Canada. Possessed of an unrivalled harbor which requires no dredging or improvements to navigation, it has lacked, always, those terminal facilities which are absolutely essential to the development of any port. Its present docking arrangements are adequate only for local shipping and go only part of the way in accommodating the present ocean trade. There is no provision either for the congestion that ofttimes arises or for that expansion which will be the resultant of the country's growth. Three transcontinental railways point to Halifax—the National Transcontinental and the Canadian Northern are definitely planned to go there, while the Canadian Pacific is equally anxious to have an independent entrance, through fuller running rights on the I.C.R. or a line of its own. The volume of traffic these roads will carry to Halifax necessitates, obviously, the enlargement of "the spout." It is considered absolutely essential to the proper completion of these great national undertakings that their ocean terminals should be commensurate to the requirements of that great and voluminous traffic they are carrying now, or will carry in the near future. In view of these considerations, the national importance of the Halifax work is apparent.

Montreal, Que.—That the by-law regulating street traffic is to be drastically remodelled, was announced at the city hall recently. The amendments to the by-law will be of such a nature that they will affect not only drivers of vehicles, autos, etc., but pedestrians as well. It appears that during his visit to Chicago last week Mayor Lavallee was much impressed with the system in vogue there. It is very simple yet very effective. At the densely congested streets two policemen are stationed. All vehicular traffic is stopped by the sounding of one whistle; while two whistles permit it to proceed. So soon as the one whistle is heard pedestrians make haste to cross the streets, but when two whistles are sounded they remain on the sidewalks till they hear the one whistle again. So familiar have these whistles become in Chicago that they are instantly understood and the system is said to work even better than the holding up of the policeman's hand. It is this system that Mayor Lavallee will inaugurate in Montreal. Chief Campeau is to be called before the Board of Control and given instructions in regard to the new order of things.

Montreal, Que.—One hundred thousand dollars has been appropriated in the sundry Civic Bill which has passed the Senate at Washington for the American end of the expenses of the International Joint Commission which is now engaged in one of the greatest surveys ever attempted between Canada and the United States. The commission has settled the Livingstone's Channel and the Rainy Lake question, and is now working on a big problem in connection with the Lake of the Woods, etc., and also on several complicated questions of pollution of waters at narrow points along the Great Lakes. The Lake of the Woods problem involves the interests of $75,000,000 of investment on the American side of the big sheet of water. The two governments want to know what is the best level to be established to serve the interests of all concerned. The sewage and pollution question is of vital interest to the region about Detroit, where the sewage of

600,000 persons is being dumped into the Detroit River, and on the Canadian side pollution from about 40,000 people is coming into the same water. The same condition exists at the lower end of Lake Erie and in the Niagara River, where the population of Buffalo is responsible for the pollution. So it is at Tonawanda and North Tonawanda, and at Niagara Falls city. It is claimed that the sewage spreads all over the lake, and that the St. Lawrence is polluted before it leaves the boundary line also.

Fort William, Ont.—The Dominion Government is maturing its plans for the building of interior terminal elevators in the West. The wheat production of the prairie provinces is increasing at such a rate as to cause a great strain upon the railways, despite their constant construction and the provision of new facilities at Port Arthur and Fort William. In addition to the large elevator now being built at Port Arthur, with a capacity of three and a quarter million bushels, and the rushing of work on the Hudson Bay Railway, the need of interior elevators is felt for relieving the congestion. For this purpose, an item is being put in the supplementary estimates. When these elevators are built all grain going in and coming out of them will be weighed and inspected and can be sold on inspection. This will enable the owners of grain to get a negotiable warehouse receipt upon which they can borrow money from the banks or sell the grain on the markets. The elevators will be so equipped as to treat wet and damaged grain, and will be of particular utility in providing a further reserve storage capacity. It is intended to build a few elevators at once to find out exactly what good they produce. If the results are satisfactory the government then will go further.

Toronto, Ont.—The Ontario Government is embarking upon extensive investigations in the matter of sewage disposal and the protection of the fresh water supplies of the province from contamination due to careless or unskilled methods. With the fact in mind that every provincial municipality located near lakes or rivers is facing serious problems of this nature, Dr. J. W. S. McCullough, chief officer of health, will visit in the summer months several places in Great Britain and the continent to discover assistance in solving the difficulties which come before his department. In view of the action taken by the provincial board, acting in conjunction with the International Joint Commission, to examine the boundary waters and discover the prevalence of pollution, a report will be forthcoming in November. The knowledge will then have been acquired by Dr. McCullough as the most practicable manner of dealing with the general situation. Legislation improved and amended at the recent session places within the jurisdiction of the board power to force instalment of whatever water systems they consider best, and if a purification plant or a sewage treating plant is thought necessary the municipality concerned will be obliged to install it without appeal to the people. This obviates much of the trouble which has occurred in unwilling towns in the past. Dr. McCullough will visit London first and go thence to Germany and France. He leaves Toronto during the week of July 1, and the trip will consume two months.

Quebec, Que.—In addition to the objections from the government of Saskatchewan to Hon. Frank Cochrane's bill providing for federal subsidies for the improvement of highways, the government of Quebec, through Sir Lomer Gouin, has now come out with a severe criticism of the bill as passed in the commons. In an official statement Sir Lomer says that it is to be greatly regretted that the federal government has not amended the bill in line with the demands of the opposition and of the senate. "I am," he says, "an advocate of good roads and I very greatly desire to see our roads improved as much as possible. But the federal government's bill does not satisfy me. I find it even dangerous in principle. It does not satisfy me because it does not insure an equitable distribution among the provinces of the moneys which parliament may vote. The ministers, it is true, have told us that according to the subsidy act these moneys will be distributed among the provinces according to population but the actual text of the law has not been worded so as to insure this. Moreover governments pass out of existence and the successors of the Borden government will not be bound by the word of the present prime minister. Why should not the present government follow the example of the fathers of confederation? Why should it not incorporate in the good roads bill the same principle which had been incorporated in the bill with regard to the advancement of agriculture? Moreover, this bill appears dangerous to me for it infringes the rights of the provinces and tends to narrow local autonomy. Article 92 of the B.N.A. Act specifies that the provinces shall have jurisdiction over all local undertakings but in what position would the provincial administration find themselves if the good roads bill became law in its present form? They would simply have to give up their rights and their prerogatives in order to get the subsidy which would be offered them or else they must give up the subsidy.

Montreal, Que.—A Town Planning Bill, under which every municipality would be compelled to draft plans of its future development, is strongly advocated by Controller Lachapelle. "Town planning," he said, "is to me the problem of the hour. The way building operations are carried on in the suburbs is a disgrace to the city. There should be a definite plan for the whole island of Montreal, homologated by the legislature, so that building would have to follow its lines; and a better-laid-out city would be gradually evolved. I think it would be a good idea to get the services of an expert, say from Europe, and give him a summer in which to draft his plan. The United States Government recognized the need of building its capital on a definite plan, and Washington is the pride of every American in consequence. The necessity of compelling municipalities to build along definite lines has been recognized by a number of European governments. They have made it compulsory for towns of over 5,000 inhabitants to build and expand on a definite scheme. We need, too a campaign of publicity to instruct the people and to bring before them the necessity of town-planning. We are annually faced with an increasing tide of immigration. The country population is moving into the city, and unless we do something quickly it will soon be almost impossible to do anything really effective. It is no use improving a little here and a little there. It is only wasted time. What we want is a definite plan."

Quebec, Que.—"This road will mean easily $1,000,000 annually to Quebec," said Mr. Geo. A. McNamee, secretary of the Automobile Club of Canada, as the first party this year to officially inspect the new King Edward highway passed along its route. Mr. McNamee was representing the club and Dr. Desaulniers, of St. Lambert, M.L.A., for Chambly, was the government for the time being. It was the first official look over the completed good road, on the way to Rouse's Point, N.Y. In all nearly twenty miles of the new work is now done, of the forty-five-mile long King Edward Road. In fine weather the new road is comfortably passable from Victoria Bridge to the New York state border line. In bad, wet weather the old St. Lambert to Laprairie section would not be any more "available" than it has for years in the past. But apart from the first twelve miles the motorist really has no great "kick" coming, especially when he looks back a year or more. Where sections of the new road

have been built driving is a delight. The Lapresse road, one mile in length, was completed last year. That is the first mile in the "cut" through to St. Phillippe getting away from the impossible Laprairie section. The remainder of the nine miles is fast being constructed and will be completed, it is thought, by August. By that time all the various sections yet untouched will be linked up with the already completed good sections, and the good road will exist in its entirety. The last contracts for the work were signed immediately on the return from abroad of Sir Lomer Gouin, premier of the province, and the completion of the new highway is going on rapidly.

Victoria, B.C.—Now that Victoria is looking forward to the construction of one of the largest graving docks in the world at Esquimalt, some notes about the Gladstone dock at Liverpool, which is the largest in existence, will be of interest. The capacity is about 50 million gallons, and the cost was about $2,430,000, or about that of the proposed dock here. Work began at Seaforth in September, 1910, and after the necessary bank had been erected to keep the water out, in January, 1911, the work of excavation was begun on the shore proper. A commodious dock over 1,000 feet in length has been constructed, lined with half a million tons of concrete, with granite coping. The striking feature lies in the fact that the new receptable may be used not only as a graving dock, but as a wet dock, and that achievement is an interesting one. The ordinary graving dock is constructed in quite a different way from the wet dock. The sides slope and are provided with steps to facilitate the shoring of the vessel. The Gladstone dock is planned differently; it is so constructed that the giant vessel can either discharge cargo, as in the ordinary wet dock, or be repaired when the water has been run off. Exceptional circumstances necessitated the experiment, the plans for which, prepared by A. G. Lyster, were carried out by W. H. Jones. Dock gates were found to be impracticable. Two sets would have had to be fixed, and to obviate this it was decided to provide a sliding caisson. The caisson, when not in use, is kept in a chamber that runs off the dock, and is operated with ease. In another chamber the pumping machinery is installed. A commodious place, very like a small dock, it will be fitted with five Diesel engines, each of a thousand horse-power. The employment of oil engines is an innovation, for all the other pumping machinery on the dock estate is dependent on steam.

Edmonton, Alta.—Regarding the Rabbit Hills gravity system the Montreal experts have presented the following report: The system seems to have a number of points which would immediately commend themselves, namely, a natural intake which would form a rough settling basin in the river. Within a distance of a mile and a half of this point on the river there is a hill 120 feet above the general level of North and South Edmonton. Nearby there is a much smaller hill 32 feet higher than the former one. There is said to be in the immediate vicinity a supply of lignite which would enable the coal to be sent direct from the mine south to the boilers in the pumping station at the riverside. By locating the reservoir on the larger hill and running liberally proportioned mains to the city it would be possible to deliver water from this source at a pressure of, say, 30 or 35 pounds per square inch at the centre of the city on the general level. It would doubtless be necessary to raise this pressure in the city by booster pumps, although we have not included a price for such a pumping station in the estimates. On the plan we have indicated an intake and pump-house at the approximate elevation of 2,070, which would deliver the water through a pressure main to the raw water reservoir on the top of the highest hill, a distance of about two and a half miles through an elevation of 322 feet. From the raw water reservoir the water would pass by gravity through the filters to the main reservoir on the general elevation of 2,360, whence it would be delivered to the city through a double 36-inch pipe line about seven miles in length. Such a system would have the advantage of uniform continuous pumpage at the pump house, and it would give a low but uniform pressure in the pipe line leading to the city. The details of the estimate of cost of the Rabbit Hills gravity system are as follows: for a population of 100,000 the estimated cost is $6,263,133; a population of 150,000 will cost $7,189,983, and 200,000 will cost $9,447,172.

PERSONAL.

F. S. LAZIER, of the Department of Railways and Canals, who was stationed at Campbellford until recently, has just returned from an extensive tour of Western Canada. Mr. Lazier is now making Toronto his headquarters.

K. A. DUNPHY has been appointed resident engineer of the Canadian Pacific, District No. 2, Alberta division, with headquarters at Calgary, Alta., in place of J. Robertson.

MR. W. D. MURRIN, of London, Eng., formerly with the London United Railway, has been appointed mechanical superintendent of the entire system of the British Columbia Electric Railway Company, succeeding Mr. S. P. Thompson, of New York, who resigned.

MR. T. KENNARD THOMPSON, the well-known consulting engineer of New York, has been re-elected president of the Canadian Club of New York for another year.

MR. D. McD. CAMPBELL, city engineer of Sydney, N.S., has resigned owing to ill health, after serving the city for the past thirteen years.

MR. GEORGE H. TOD, of Toronto, who is the Canadian representative for Ashworth-Parker engines, Bennis mechanical stokers and Broadbent's cranes, capstans, etc., is making a six weeks' tour of Western Canada. Mr. Tod recently opened a western office at 601 Union Bank Building, Winnipeg.

MR. C. M. WATERMAN, manager of the Eugene Dietzgen Company, Limited, Toronto, is making a month's trip through Western Canada. Mr. Waterman will call on his return at his firm's Chicago factory, which is making every effort to fulfil all the requirements of the Canadian field. Mr. Dietzen, a brother of the founder of the firm, and one of the present heads of the business, will make an extensive trip through Canada later in the season.

OBITUARY.

There has just died at Hayward Heath, forty miles south of London, an Englishman whose name is known to railroad men throughout Canada; John Saxby, of the firm of Saxby & Farmer. He died, at the age of 92, on Wednesday, April 23. The first patent bearing Saxby's name was taken out in 1854, for a signal lamp with a movable inner case which changed the color of the light as the signal arm moved up or down. This was the joint invention of Saxby and W. V. Greenwood. Saxby's first interlocking patent—the invention which has made his name a household word among signal men all over the world—was taken out in June, 1856. His first installation was an interlocking of eight signals and six switches at Bricklayers' Arms Junction, where fifteen years before the semaphore designed by Gregory had been first introduced. In 1860, Austin Chambers patented an improvement on Saxby's idea, but a few months later Saxby made still further improvements, and thereafter kept the lead over all his competitors. His patent for preliminary latch locking

was taken out in March, 1867. The firm of Saxby & Farmer was established about 1860. W. M. Punter is the Canadian representative of the firm with headquarters at Montreal.

ONTARIO HEALTH OFFICERS' ASSOCIATION.

The second annual meeting of the Ontario Health Officers' Association will convene at the Parliament Buildings on Thursday and Friday, May 29 and 30th.

Amongst those who will address this meeting are G. C. Whipple, Professor of Sanitary Engineering, Harvard University; Dr. Chas. A. Hodgetts, Medical Advisor to the Committee of Conservation; Dr. Chas. J. Hastings, Medical Officer of Health for Toronto; Lieutenant-Colonel Laurie, Port Arthur, and many others. It is provided by the statutes that all medical officers of health shall attend—as there are about 850 of these officers in the province, the attendance should be a large one.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25, Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa, Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kehlor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, May 29, 1913

Contents of this issue on page 787

The Canadian Engineer

An Engineering Weekly

THE LAYOUT OF A SMALL RIVER CROSSING

By C. D. NORTON.

The completed bridge, as shown in Fig. 1, is 650 feet from ballast wall to ballast wall; five 40-foot towers being connected with six 75-foot D.P. girders; height of water-towers, 75 feet. An ideal location (Fig 1) made it difficult to lay out, owing to the steepness of the banks and to the fact that each abutment stood on a promontory; added to which there was 300 feet of water in the middle.

The location tangent was established and chainage between hubs checked by a rough triangulation, a topographical sketch made, and conditions determined the base line as shown. (Fig. 2). Hubs were set every 10 feet and a double one at 100 feet for plumbing down; each set of 10 being levelled, the total drop in the 200 feet being about 5 feet. This base line was measured with with a 100-foot band chain and the three angles were repeated four times on each quadrant. A tabulation showed any radical errors and the average for each angle was taken out to 15 seconds.

Fig. 1.—Showing Completed Bridge.

Having determined the distance between two hubs which were approximately 650 feet apart, this exact distance was staked and checked by the same method. At a later date, when the pond was dried, the distance taped was found to be .06 foot shorter than the distance triangulated, a discrepancy due to the fact that the heavy band chain could not be stretched to its proper length without supports. Six hubs were then set on banks for the line of the pedestals from each side was chained separately. The face of ballast walls and centre of pedestals was referenced at right angles by hubs set out closer than 100 yards, one in fact being one-quarter of a mile up the valley. This completed the layout.

The abutments were checked every 5 or 6 feet during erection, tbe carpenter being given the centre line and face of ballast wall.

The depths of the pedestals were approximately determined by soundings, and staked accordingly. After tbe footings were in, hubs were set on the centre and reference lines, an intersection obtained with fine fishing line, and these lines transferred to the footing, on which the base of the foustoum was staked out. When the form was built the top was checked in the same manner. After the concrete was finished centres were marked on the pedestals from the reference points and checked with tape. On all important lines, wherever possible, foresights were set to eliminate double centering and to dispense with having to send a man around the dam to give point.

The first levels were, of course, the check levels over the section, when bench marks were set on each bank and at water level. Bench marks were then set every 12 or 13 feet down the banks and levels taken four times. These were tabulated, showing the differences between back and foresights which was the difference in elevation between benches and established a definite relation between them independent of initial or accumulative errors, any radical difference was eliminated and a mean struck which gave the elevation for the bench marks. Afterwards, whenever levels were run, the work was checked on to the next bench mark and the book elevations marked on the same sheet, thus obtaining an average in which final elevations were correct to within .01 foot. To set levels for the bridge seats temporary pillars were set on each side of the abutment and the height, some 30 feet, taped up, a line joining the points at the top being checked with a carpenter's level.

Elevations were, of course, given for the top of the pedestals, but owing to the shrinkage of the concrete and the varying temperaments of the men who floated the tops, the finished work varied as much as .05 high or low. The base of the columns was marked on tbe pedestals, and levels taken at each corner. These were tabulated in sets of four for each pier, and a mean struck which gave the least chipping, a difference of .01 in 75 feet being inappreciable. With an improvised target rod (a pencil point on a picket) the four corners of each seat were chipped to .001 foot and then

levelled by a stone mason, any low pedestals being chipped for to use a plate.

The foregoing may seem rather elaborate for a small bridge, but as neither the foreman in charge or the carpenter had done any large concrete work before it was none too much, and the end justified the means, for when the bridge

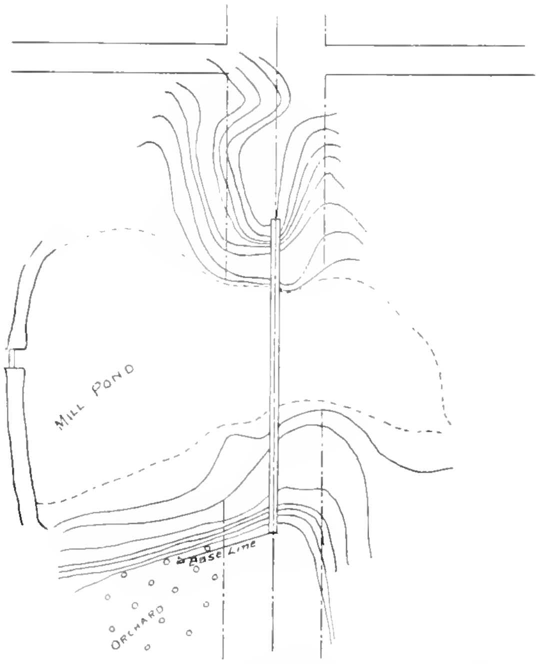


Fig. 2.—Layout of Small River Crossing.

company laid track, spiking to centre of girders, there was no need of relining when the bridge was finished.

The instruments used were a 5-inch transit reading to minutes, a 14-inch dumpy level, a self-reading rod graduated to half tenths, and a band chain.

AMERICAN WATERWORKS ASSOCIATION.

The thirty-third annual convention will be held at West Hotel, Minneapolis, Minn., June 23rd to 27th, 1913.

The following papers are scheduled: "The Diesel Engine for Waterworks," by Edward S. Cole; "Waterworks Special Franchises," by Henry DeForest Baldwin; "Reforestation and General Care of Watersheds," by Ermon M. Peck; "The Bacterial Count on Gelatin and Agar Media and its Value in Controlling the Operation of Water Purification Plants," by James M. Caird; "The Tuscaloosa, Alabama, Waterworks," by Prof. Edgar B. Kay; a paper on filtration, by George W. Fuller; "Charges for Public Water Service to Private Fire Protection Systems," by W. E. Miller; "A Reasonable Basis for the Determination of Charges for Private Fire Protection," by Leonard Metcalf; "Metering Private Fire Services at Kenosha, Wisconsin," by August Baltzer; "How a Private Fire Service Polluted a Public Water Supply and Some of the Consequences," by Robert J. Thomas; "Modern Filter Practice," by Nicholas S. Hill, Jr. "Gravity Water upply at the City of Manila, Philippine Islands," by H. E. Keeler; "Power for Pumping Derived from Refuse," by E. H. Foster; "Pumping Engines," by L. E. Strothman; "Ground Water Supplies," by Charles B. Burdick; "Rates and Rate Making," by Halford Ericson.

On Tuesday and Thursday evenings illustrated lectures will be delivered by Edward Wegman and Dr. William P. Mason.

There will be excursions on Wednesday and Friday afternoons.

NOTES ON SEWAGE DISPOSAL.

By Geo. W. Swinburne, M. Am. Soc. C.E.*

The liquid portion of sewage is not, to any appreciable extent, beneficially affected by being subjected to tank treatment. But, in addition to its dissolved impurities, sewage carries suspended solids, some of which can be eliminated by efficient tank treatment, and others which, under practical working conditions, are not depositable by sedimentation alone.

The operation in ordinary settling, or sedimentation, tanks is a comparatively simple one, since there are but two forces at work, the forward movement of the sewage and the force of gravitation acting on the suspended solids. These solids will be deposited at variable distances along the tank bottom, forming a gradually rising floor of sludge, diminishing the liquid capacity of the tank, increasing the rate of flow of the sewage, and finally causing a greater proportion of suspended matter to pass out with the effluent than is consistent with successful operation. When this condition is reached the tank should be put out of commission, emptied and cleaned.

In septic tanks the decomposition of the sludge results in the addition of a third force. It is often assumed that septic action results in the liquefaction of the organic portion of the sludge, but, while some liquefaction does occur, the result is essentially a gasification. These gases work in opposition to the force of gravitation acting on the suspended solids, and are the chief cause of the large amount of finely divided suspended matter found in septic effluents.

Since septic tanks have a longer sedimentation period and a greater sludge storage capacity than plain sedimentation tanks, the interval between cleanings is naturally longer, but the final result, putting the tank out of commission for emptying and sludge withdrawal, is the same in both cases.

Following a careful study of the results obtained with the two-story tank at the Lawrence Experimental Station of the Massachusetts State Board of Health and an exhaustive investigation of the conditions in which suspended matter is found in sewage, Dr Wm. Owen Travis, of Hampton, England, designed what is now known in England as the Hampton, or Travis, Hydrolytic Tank and in this country as the Hampton Sedimentation Tank. The results sought in designing this form of tank may be stated as follows:—

(1) To effect the sedimentation of the depositable solids of the sewage in such a manner as to maintain continuously the predetermined capacity of the sedimentation chambers.

(2) To increase the sedimentation efficiency and remove the liquid products of the decomposition of the deposited solids by causing a minimum proportion of the sewage to flow into and through the reduction chamber.

(3) To separate the opposing forces of gravitation and gaseous eruption by confining these operations to separate compartments.

(4) To provide for the removal of sludge at will and without interfering with the continuous operation of the tank.

The first tank of this type was constructed in 1904 at Hampton, England, to relieve the rapid clogging of the primary contact beds. An official report by Mr. J. H. Johnson, M.S., F.I.C., London, England, covering a period of six months' operation of this tank shows an average retention of 90 per cent. of the suspended solids of the raw

* Mr. Swinburne, to whom we are indebted for the compilation of the above notes, is chief engineer of the Sterilization Company, Newark, N.J.

sewage. Referring to a later and much larger installation at Norwich, England, Mr. Arthur E. Collins, Mem. Inst. C.E., City Engineer, Norwich, states: "The operation of the tanks in Norwich has been uniformly successful. The average removal of solids amounts to between 90 and 94 per cent. of the total contained solids of the crude sewage."

The tanks at Norwich are divided into three longitudinal compartments, of which the two upper are for the sedimentation of the sewage and the lower one for the collection and retention of sludge. The sedimentation chambers receive the entire volume of sewage, the greater portion of which traverses their full length and is discharged over weirs into the effluent channel. A small portion of the sewage descends through openings at the bottom of the sedimentation chambers, carrying with it the accumulated suspended solids, passes through the reduction chamber at greatly reduced velocity, and deposits its burden of suspended solids in the sludge pockets at the bottom of the chamber.

Any action in the reduction chamber will be similar to that in a septic tank, but in a more or less modified form, depending on the length of time the sludge is retained. With long sludge retention there will be the same formation and eruption of gas and resulting disturbance of the sludge, which, however, has no effect on the liquid flowing through the sedimentation chambers. Following such eruptions, the reduction chamber effluent will carry some of this disturbed deposited matter out of the chamber. These solids are eliminated in the small up-flow chamber through which this effluent passes.

Owing to the fact that English sewage is at least three times as strong as American sewage, it is commercially impossible to eliminate from American sewage by sedimentation alone as high a percentage of suspended solids as is stated above. All the available data indicates very strongly that under average American conditions the sedimentation chambers of two-story tanks should have a capacity of from one-tenth to one-eighth of the total daily flow of sewage. With an average retention period of from two and one-half to three hours the Hampton tank will show an elimination of suspended solids of about 65 per cent.

Sludge storage capacity should be determined in each case by such local conditions as climate, proposed method of sludge disposal or utilization, subsequent treatment of the effluent, etc.

The electrolytic treatment of sewage is not a new idea; Webster patented such a method of treatment in England nearly twenty-five years ago. Electrolytic sewage treatment works which seem to follow Webster's method in a general way are in operation at Santa Monica, Cal., and at Oklahoma City, Okla., but in neither case is any attempt made to clarify the sewage nor to obtain the benefit of the secondary, or time, reactions, which would materially reduce the cost of operation.

There are many cases in which a well-clarified effluent, if free from pathogenic germs, would meet all reasonable requirements. In such cases the sewage, or so much of it as may be necessary, can be subjected to an efficient preliminary electrolytic treatment and then passed through a Hampton tank to allow time for the secondary reactions and for clarification. Electrolytic treatment not only produces a powerful germicide, sodium hypochlorite, from the salts which are always present in sewage, but it also serves to coagulate the finely divided suspended solids, or colloids, and the simpler forms of dissolved organic matter, which can then be eliminated by sedimentation. Furthermore, since sedimentation is much more rapid after electrolytic treatment than under natural conditions, a material reduction can be made in the capacity of the sedimentation chambers without reducing the percentage of clarification.

This combination of electrolytic and tank treatment makes it possible to eliminate from 80 to 90 per cent. of the suspended solids of the crude sewage, make an appreciable reduction in the dissolved solids, and produce an effluent which is well clarified, odorless and free from pathogenic germs. The danger of such a plant ever becoming a local nuisance is reduced to a minimum.

DISPOSAL OF REFUSE IN TOWNS AND CITIES.

Refuse disposal is usually a serious problem for the small city or town to solve. In such cases public incinerators are not always economical and the ordinary dump needs careful regulation to prevent it becoming a nuisance.

Burning or burying is the most desirable method of disposing of ashes, rubbish, manure and garbage in cities. Of these, burning is the most sanitary, and no other means should be used in cities having a population of, say, 20,000, or more. Refuse incinerators are of two main types (1) the coal-fired or "low temperature," and (2) the high temperature. The latter is designed to handle mixed garbage without the use of coal. Very few of these have as yet been installed, and their advantages have not been entirely proven. For the coal fired incinerator a long-flaming coal of good quality is essential. This, of course, makes the cost of operation all but prohibitive for most small cities and towns.

In such cases, other means of refuse disposal must be obtained. To simply dump garbage in an unrestricted manner on some vacant lot should be classed as a criminal offence, and punished accordingly. The practice of burying refuse, where it is carefully carried out, is usually found to be cheap and at the same time effective.

The principle upon which refuse burial rests, especially as applied to garbage, is, primarily, a bacteriological one. The action of the soil bacteria is to mineralize the organic matter in the refuse. In order to prevent the occurrence of putrefactive or other objectionable odors the mineralizing process must be carried out in the presence of sufficient oxygen or air. To secure these conditions the following points should be observed: (1) The garbage should not be buried too deep, nor should it be spread in too thick a layer on the ground. (2) The ground used should be sufficiently porous and well drained to admit the air readily. (3) The garbage should be mixed with enough other refuse to prevent overloading the soil.

These conditions are obtained in different ways. In some cities the refuse is spread on the ground and then ploughed under. Another method is that of digging a trench, covering each day's collection of refuse with the soil, removed for the next day's supply. In any case, refuse that can be burned should be so treated and garbage and other organic waste can be more effectively handled by mixing it with other waste such as ashes, street sweepings, etc. It is claimed that 1.5 acres are necessary to handle each daily ton of garbage permanently. The soil can be re-used at the end of two years.—Conservation.

Three free scholarships, each covering four years' tuition in the Faculty of Applied Science at McGill University, have been offered by the Grand Trunk Railway Company to apprentices and other employees under twenty-one years of age, sons of railway employees. The competitive examination will be the regular university matriculation examination, beginning June 12th. The three candidates making the highest scores will receive the scholarships. Students will be required to enter the service of the company during vacation periods.

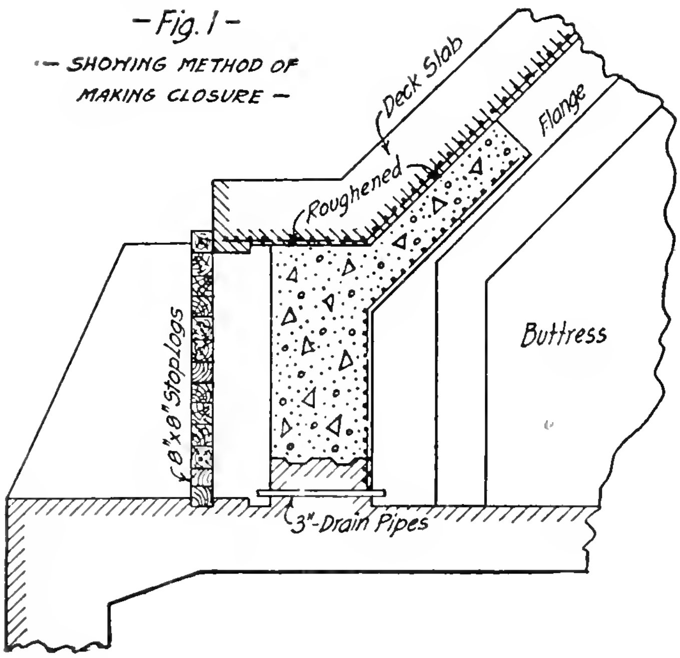
REINFORCED CONCRETE HOLLOW DAM OF BUTTRESS TYPE.

By J. K. Finch and W. F. Thoman.

Concrete-steel is a relatively new material and the design of structures involving its use has not yet reached that state of standardization which exists, for example, in structural steel work. Certain tables and rules have been devised but in the details of design much is left to the ingenuity and practical skill of the designer. The nature of the material and its method of fabrication are almost entirely responsible for this. The manufacture of steel is carried out in a shop under ideal conditions for fabrication and inspection, and its erection is merely a matter of assembling and putting together the various units that go to make up the structure. Reinforced concrete, on the other hand, is manufactured in place, in the field, sometimes under far more ideal conditions, and by labor that is, for the most part, unskilled. Its supervision should always be in the hands of experienced and competent men. Unfortunately, this is not always the case and oftentimes the caliber of the construction organization will have considerable influence in determining the details of design.

- Fig. 1 -

— SHOWING METHOD OF MAKING CLOSURE —



The forms, or molds, for the concrete exert even a greater influence. The cost of the forms is usually from one-half to two-thirds of the entire labor cost in a concrete structure, and very often economy of materials must be sacrificed to the simplification of the form work. As a general rule, all details should be made as simple as possible. Where the erection is to be beyond the control or supervision of the designer, great caution should be exercised in designing and delineating small but important details which may appear unimportant to the man in the field. The monolithic character of concrete will also introduce stresses due to continuity which may sometimes be used to advantage, but must always be provided for. Contraction and expansion must also be taken care of by the designer and not left to the ingenuity of the erector.

In this and the following papers, the notation, formulæ, unit stresses, etc., recommended by the Joint Committee on Reinforced Concrete will be mainly followed.*

* Proceedings, Am. Soc. C.E., February, 1913, p. 117.

Four or five types of hollow concrete dams have been developed, but the most widely used and the original form is the buttress type, which is here discussed. This form is patented by the Ambursen Hydraulic Construction Company, Limited, of Boston, Mass.

The first dam of this kind was built at Theresa, N.Y., in 1903, and was designed by Messrs. Ambursen and Sayles, of Watertown, N.Y. Since that time, over 75 dams have been built, varying in height up to 150 feet and in length up to 1,200 feet.

It is not the purpose of this paper to discuss at any length the merits of this type but a brief summary of its advantages seems desirable.

Compared with the regular gravity section of stone or cyclopean masonry we note that the latter is usually designed in such a way that the resultant pressure on the base acts at or near the down-stream edge of its middle third. Here the water pressure is turned downward by the weight of the masonry alone, and it is readily seen that an increase in head on such a dam will cause the resultant to pass outside the middle third, producing tension at the upper toe and finally overturning the structure if it does not fail in some other way before this occurs. In the hollow type the inclined slab causes the water pressure to be directed downward at all times, and the resultant pressure can be made to cut the base at any desired point by varying the design.

The facility with which the base pressure may be reduced in intensity by spreading the base, and made uniform over the base by correct proportioning is one of the marked advantages of this type of dam. In some cases, where the river bed is a hardpan or cemented gravel, overlying impermeable strata, the dam may be built directly on this material, because of this fact, and no deep foundations need be used. Extreme caution should be exercised in using this form of construction, however, and in general the buttresses should rest on rock or its equivalent, and the cut-off wall should extend to impermeable strata below all possible underflow.

The danger of ice thrust is also eliminated, as an ice jam would be forced up the inclined slab and its weight distributed over the structure, or, if the water were high enough, would be forced over the top of the dam.

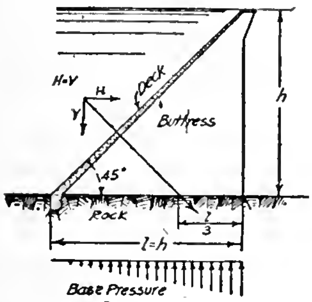
While the hollow dam will, in general, cost less than a masonry structure of the gravity type, and while there are many places where the easy control of base pressure in the former makes it available because the cost of the latter would be prohibitive, no fixed cost relation can be given. Reinforced concrete work requires steel and lumber, the cost of which may, in some localities, be excessive, making a gravity dam more economical.

No actual failures have been recorded, but the oldest dam has been in service only 10 years. Cases have occurred in which the foundation has washed out under the dam, which has arched over the opening and remained practically intact. These serve to emphasize very forcibly the necessity of having the cut-off wall extend to a sufficient depth. It should also be remembered that the strength of the structure depends primarily on the imbedded steel, which must therefore be fully protected from rust. This can be done only by proper allowance for temperature cracks, by the use of expansion joints, and by using a concrete which will be essentially watertight.

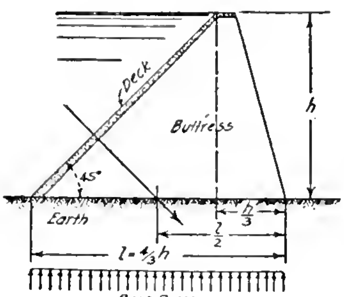
Spillway.—Several types have been developed, depending on the head and on the foundation material. On ledge rock, a spillway section with a complete or part rollway is used when the fall exceeds 10 feet or thereabouts, depending on the quality of the rock surface and its ability to withstand the force of the falling water. On soft material, either a

water cushion must be formed for low heads, possibly by slightly extending the base of the dam and placing a small barrier dam at its downstream edge, or a complete rollway, with or without an apron to prevent scour, must be used.

Construction.—The usual method is similar to that employed in the construction of masonry dams, but the required cofferdam is usually far less costly and of a more temporary character. The foundation and lower sections of the bulkhead are first constructed, and the entire flow of the stream is allowed to pass through this partially completed section while the upper parts of the buttress and slab are being erected and the remaining portions of the dam completed. The final closure is usually made as shown in Fig. 1, without employing any expensive cofferdam. This method is patented. The procedure in the erection, field joints, and forms will be discussed further on.



- Fig. 2 -



- Fig. 3 -

Slope of Deck and Shape of Buttress.—The deck slope is generally made 45 deg. The reason for this becomes clear by reference to Figs. 2 and 3. Fig. 2 represents a dam on a rock foundation where the resultant base pressure may be allowed to take the triangular form, i.e., the resultant may cut the base at or inside the middle third. This result must be obtained at the least cost. Neglecting the weight of the dam itself, and drawing the buttress with a vertical downstream face, which will evidently be the minimum practical form, it may be easily shown that a 45 deg. slope for the deck just satisfies this condition. A steeper slope would result in a little saving in the deck but would require an addition to the buttress on the downstream side to keep the resultant within the required limit. A greater slope would result in an increased slab and buttress. The relation, base equals height, therefore represents the economical proportions for this type of dam on a rock foundation.

On some foundations it is evident that it will be advantageous to have a practically uniform distribution of loading over the base. A brief consideration will show that this can best be obtained by applying an additional downstream section to the buttress, as shown in Fig. 3, giving a total bottom width equal to 1⅓ h. The uniform distribution of pressure could have been obtained, it is true, by decreasing the slope of the deck, but this would result in increasing the vertical component of the resultant water pressure and thus also the intensity of the base pressure, a condition not desired. It is therefore clear that the slope of the deck may be made 40 deg. for all conditions and, in softer material, the buttress may be given a downstream slope of between 0.25 and 0.33 of its height; this will bring the centre of pressure about the centre of the base, when the weight of the dam is considered in conjunction with the vertical component of the water pressure.

The top width of the buttress may be zero, but will generally be made 3 or 4 feet, to provide additional strength for ice thrust, where such is liable to occur, or to carry a walk across the top of the dam to facilitate inspection, etc. Where no ice is expected the walk may be carried on brackets, as shown in Fig. 2.

Buttress Thickness.—The buttress may have a tapering section, varying from a minimum thickness of 12 in. at the top to dimensions determined by the allowable pressure on the concrete, and shear at the different depths. The tapered section is, however, not so advantageous from the constructor's standpoint as a vertical section, increasing by offsets at intervals of 10 or 12 ft.; this plan offers a support for the bottom of the forms for each "lift." The minimum section should therefore be of 12-in. thickness for not over 10 or 12 ft., and should be increased in thickness 2 in. for each additional 10 or 12 ft. of depth, or as required by the working stresses in the concrete. A 1:3:6 concrete is commonly used for the buttresses, the allowable compression on which may be taken at 300 lb. and direct shear at 75 lb. per sq. inch.

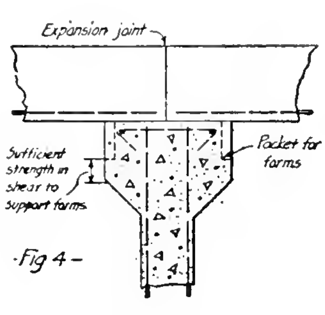
Struts.—These should be introduced at suitable points to brace the buttresses transversely. They should be placed a distance apart not over 15 times the thickness of the buttress and, to facilitate construction, should be placed at the levels where the offsets in the buttress occur. Their least dimension should not be less than 1/15 the distance between buttresses, and they should be reinforced to act as columns and carry their own weight as beams.

Spacing of Buttresses.—This will usually be between 14 and 18 ft., depending on the height and unit costs. As the distance, centre to centre of the buttresses is decreased, the span of the deck slab is decreased, and hence a saving in its cost results. More buttresses will be required, however. It is therefore clear that there must be some spacing which results in the greatest economy.

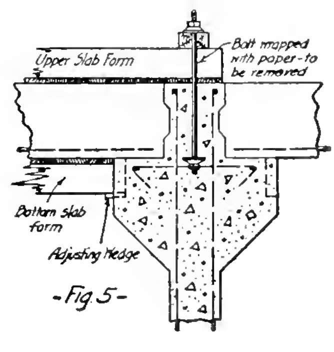
This economical spacing may be determined by the formula:

$$l^3 = \frac{370 + 17.5\,h}{\sqrt{\frac{h}{2}}}$$

in which h represents the average head and l is the spacing of buttresses. This formula can be readily derived by finding the volume of concrete and steel, and the area of form



- Fig. 4 -



- Fig. 5 -

work in the deck, buttresses and foundations in terms of h and l; applying to the same certain assumed unit prices and taking the first derivative of the total cost with respect to l. By equating this result to zero the value of l as above is found to satisfy the conditions of minimum cost under the units assumed. The unit prices will, of course, vary with local conditions but it will be found upon analysis of the formula that even under considerable variation in the unit prices the value of l will not change much. The prices assumed in this case include only the items affected by a variation in the buttress spacing, and were as follows:

Concrete in deck	14.0c. per cu. ft.
Concrete in buttress and foundation	12.0c. per cu. ft.
Steel in deck and foundation	1.9c. per lb.
Steel in buttress	2.0c. per lb.
Forms (labor only)	10.0c. per sq. ft.

Substituting in the above equation the average value of h, which is 18 ft. for the design hereafter considered, gives the economical spacing of 15 ft., which has been used.

Buttress Flanges.—Two methods are available for making the connection between buttresses and adjoining slabs. A continuous slab over the buttress would not be used, as expansion joints will be placed here to prevent cracks from forming in the deck. This point has already been discussed, and is of vital importance.

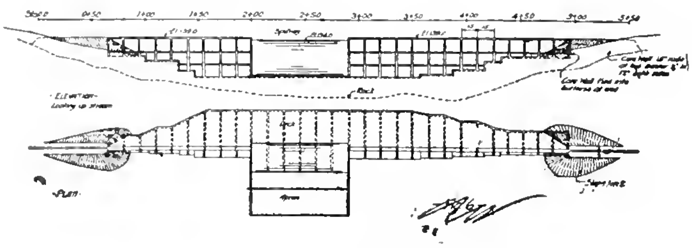


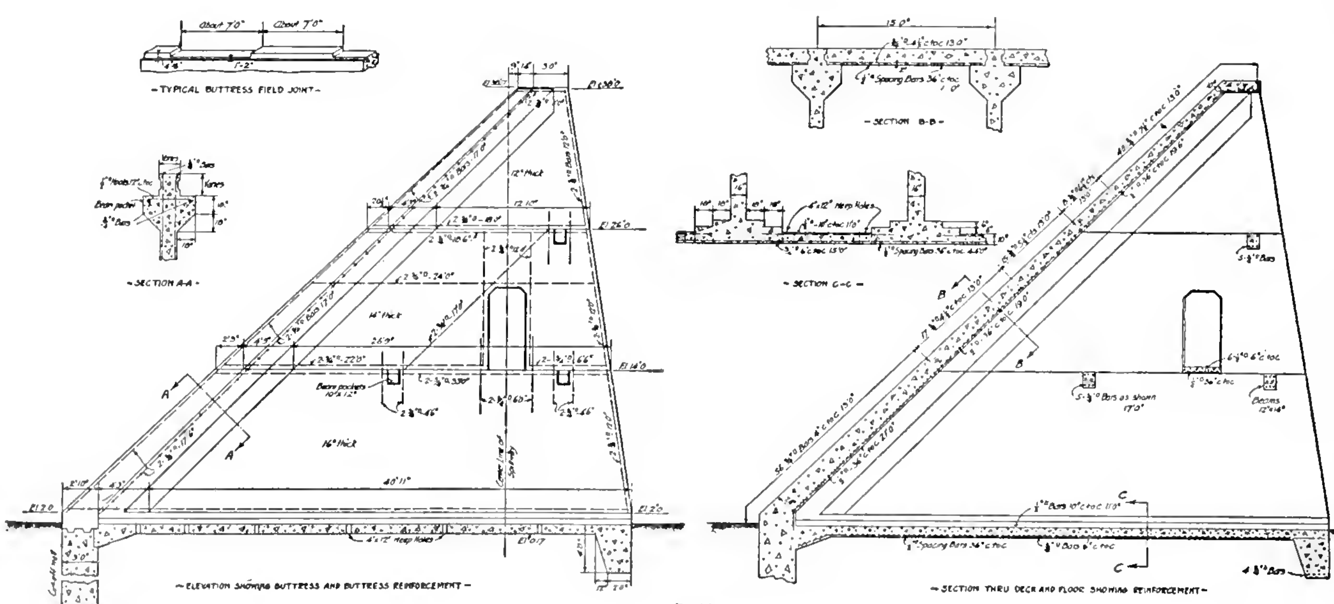
Fig. 6.

The type of joint shown in Fig. 4 is evidently very simple and would doubtless be preferred by some engineers, as it would be less costly than that shown in Fig. 5. The latter possesses some important advantages, however. Thus, the joints for expansion are doubled. The projecting portion between the slabs is cast with the buttress and not only furnishes lateral stability to the buttress from the slabs, but also furnishes a support for the top slab form and acts as a bulkhead when the slab is cast, thus saving this troublesome detail. It enables a bolt to be set in, as shown, to hold the outside form for the slab, said bolt being removed with the forms without leaving any hole through the slab. The slab span is also shortened by the greater projection of the flanges, and its cost is reduced, while the large mass of concrete thus concentrated in the flanges adds greatly to the stability of the structure.

The design of these flanges is largely a matter of judgment. It has been shown by tests of simply supported beams, with straight horizontal rods, that the length of support (overhang of the bracket or flange) must be greater than that required simply to keep the bearing pressure within reasonable limits, or the beam will fail in bond at the ends. It may also be shown by a simple computation involving the increase of concrete and steel in the projection, and the corresponding saving in the concrete and steel of the slab, that for economy the average projection may generally be made about equal to the average slab thickness.

If we attack the problem in another manner, that is, by computing the thickness required for shear, we shall generally arrive at about the same figures. Thus recent tests[1] have shown that a plain concrete bracket will take an ultimate shear of about 100 lb. per sq. in. on the section where it joins the buttress. The same tests prove conclusively that the hook form of reinforcement, such as is shown in the design herewith given, is the most efficient form and that brackets so reinforced may take as high as 400 lb. per sq. in. ultimate shear. It would therefore appear to be reasonable to compute the flange for, say, 40 to 60 lb. per sq. in. The slope of the bracket outward from the buttress certainly should not be made greater than 45 deg. and the minimum thickness of the flange at the outer edge must be sufficient to give a bearing with the required strength in shear for the ends of the beams which support the form for the bottom of the deck slab, as shown in Fig. 5. All these points must therefore receive due consideration in designing this important detail.

The flange may, of course, be decreased in size toward the top of the buttress, and this would be done in very high dams. In dams of moderate height, however, it will be seen that economy in forms makes it desirable to keep the projection the same throughout, and simply cut down the depth or thickness. This can be easily done, using the same forms throughout, if they are properly designed. In the design hereafter considered, the same projection is used throughout.



- Fig 7 -

The size of reinforcing rods is largely a matter of judgment. Tests show that the best form is the horizontal hook. Two vertical rods are run down the flanges and the smaller transverse bars are hooked over them. These hooks and rods serve the double purpose of reinforcing the projection

[1] Concrete-Cement Age, February, 1913, p. 68.

as a cantilever, and also in aiding to take up any tension in the direction of the slab, due to the friction between the slab and the bracket, which may occur if the slab contracts.

Deck.—The thickness of the deck slab should not be less than 10 in. at the top, to allow space for properly placing and tamping the concrete on the deck. This concrete should be a rich, dense mixture, usually 1:2:4, and should be mixed wet to insure the filling of all voids and the thorough coating and protection of the rods.

It will generally be found that if the thickness is assumed as 10 in. at the top, and is computed at the bottom of the buttress, that a straight line between these points will give a sufficient thickness at any depth. A change in deck slope at each lift may be made without any difficulty, so that economy will result if the thickness is computed at these points and the slope made uniform between them.

Slab Formulas.—The following formulas may be easily deduced from the thickness of the slab and the required amount of steel for bending at any depth.

Let w = weight of any liquid in lb. per cu. ft.
x = depth of liquid on slab in ft.
l = span of slab in ft.

Then the bending moment in the slab $= wxl^2 \div 8$ for a non-continuous slab, and with water at 62.5 lb. per cu. ft. $M = 7.818xl^2$. But from formula for reinforced slabs, $M = Cbd^2$, and we have $d = \sqrt{\dfrac{7.818xl^2}{Cb}}$ .... (a)

For a 1:2:4 concrete, with $n = 15$, $f_c = 600$ and $f_s = 14{,}000$ lb. per sq. in., $C = 8.50$ ft. lb. and $b = 12$ in. for a slab. Hence in non-continuous beams, d in inches $= 0.277\, l \sqrt{x}$ .... (b)

Also from the formula $A_s = \dfrac{M}{f_s jd}$ we have $A_s = \dfrac{7.818xl^2}{f_s jd}$ per ft. width of slab, where A_s is in square inches. Now the spacing of the bars in inches to obtain this area is $S = 12 \times$ area of one bar $\div A_s$. Hence the spacing at any depth is:

$$S = \frac{12 \times \text{area of one bar} \times f_s jd}{7.818xl^2} = K\frac{d}{x} \text{ .... (c)}$$

where K is a constant when the size of the bars to use has been decided on, the other quantities being known.

The shear, as a measure of diagonal tension, may generally be taken at a somewhat higher figure than customary as the slab will be so thick in proportion to its span at the depth where the shear is high that considerable arching will occur. Taking this figure at 60 lb. per sq. in. we find: Reaction per inch of slab

$$= \frac{62.5lx}{2 \times 12} = \tfrac{7}{8} \times 60d = \tfrac{7}{8} \times 60 \times 0.277\, l\sqrt{x}$$

giving $x = 31$ ft.; that is, when the height of dam exceeds 31 ft. the shear in the slab neer the buttresses becomes the limiting factor. As the depth increases a slab of arched section may be used, giving a sufficient thickness of concrete at the ends that the shear will not exceed 60 lb. per sq. in., and the required steel is introduced for bending. An increase in the strength of slab to resist diagonal tension could, of course, be obtained by using stirrups. This would permit a shear up to 120 lb. but it would be very difficult, if not impossible, to place the stirrups properly in constructing the slab, hence this method is not used.

Foundation.—On firm ledge rock no spread footing may be necessary, but on softer rock a stepped-out footing can be used. By varying the width of footing the unit pressure may be made almost uniform, even with a buttress of the shape shown in Fig. 2. In some cases, the bases of the buttresses are stepped out, the thickness and amount of steel being computed, with due allowance to shear and bending, on the assumption that the spread acts as a cantilever, and the remaining space between buttresses covered with a reinforced floor which is computed as a continuous beam supported by the cantilever footings. Weep holes are placed at intervals throughout the base to prevent upward water pressure on it.

The angle of the resultant pressure on the base should also be investigated, and proper precautions taken to prevent sliding of the dam.

Spillway.—The length, elevation, and depth of probable flood flow having been decided on, it remains to take care of this flow so that no damage will result to the structure. The following formula has been used in designing the curve for the upper part of the spillway.[3]

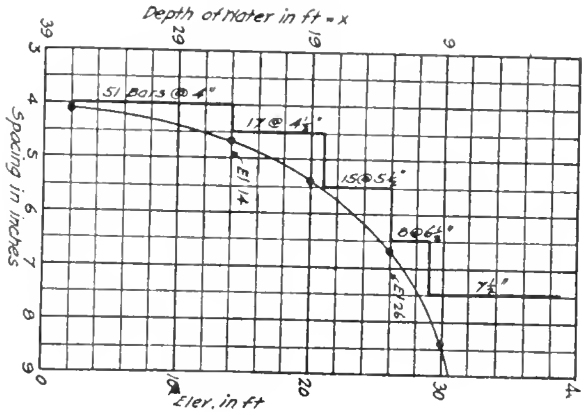


Fig. 8.

$$x^2 = 2.3 \times H \times y \text{ .... (d)}$$

Where x = the offset in feet.
y = the distance below crest in feet.
H = depth of flood flow in feet.

It is believed that this equation gives a spillway curve such that the overflowing water will adhere to the spillway surface and no vacuum effect will be possible. In order to guard against this, however, vent pipes are introduced in each bay, as shown in the accompanying drawing.

No satisfactory method seems to have been developed for designing the lower curve of the ogee section. In the design given this curve has been made the reverse of the top curve, which seems to be a safe procedure.

The design of the curved spillway slab is essentially a matter of judgment, the thickness and reinforcing depending on the expected flood flow and the possibility of logs, ice, etc., being carried over the dam.

General Conditions.—The general layout and profile are shown in Fig. 6. The conditions for the design are as follows:—

In order to illustrate the method followed in such a design, the river bed will be assumed as hardpan and the conditions such that the dam may be built on a spread foundation resting directly on the river bottom, provided the foundation pressure is made uniform and at an intensity not to exceed 2 tons per sq. ft. A full rollway section for the spillway, with downstream apron to prevent scour, is also desirable.

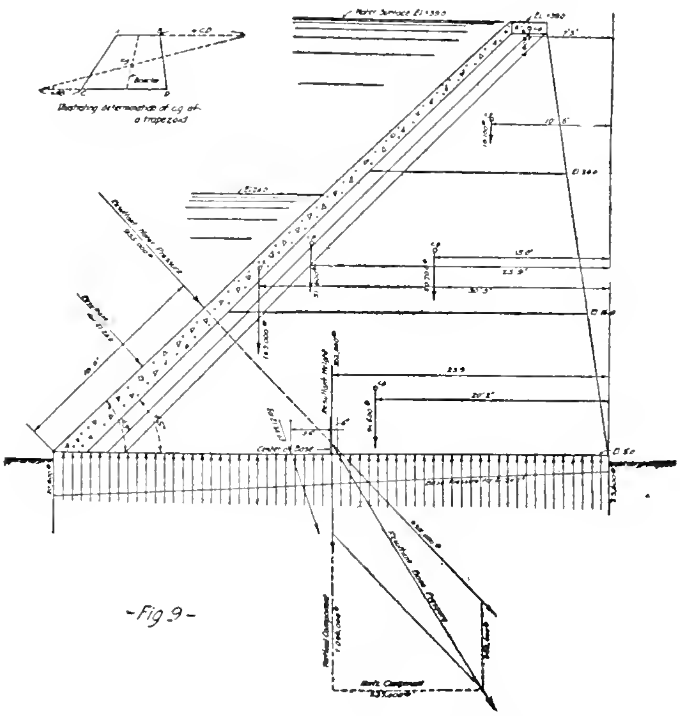
---

[3] Eng. Rec., October 24, 1908, p. 461.

Elevation of crest of spillway will be taken at + 36 ft.; maximum flood height 37.5 ft.; and crest of dam + 39 ft., making an allowance for waves, etc., of 1.5 ft. Dam will be designed for a head of water equal to the full height of dam and the spillway to pass a 3-ft. flood.

Unit stresses in lb. per sq. in.

	Deck and apron.	Buttress.	Footing.
Mixture	1:2:4	1:3:6	1:3:6
Concrete in compression	600 (bending)	300 (direct)	500 (bending)
Concrete in shear (direct)	—	75	75
Concrete in shear (diag. tension)	60	—	40
Steel in tension	14,000	—	14,000



-Fig. 9-

The section at greatest depth only will be designed. For other depths, a similar section is used, the floor system being stepped up, as shown in Fig. 6, with step-up walls designed to assist the lateral earth pressure, and provided with pipe drains to prevent the possibility of water pressure.

Buttresses.—Width of base will be made about 0.3 greater than height (37 ft.) or 48 ft. Top width for walk, 3 ft. Built in three lifts of 12 ft., and thickness of 12, 14, and 16 in., as shown on Fig. 7. Reinforcing bars will be placed as shown to tie the buttress together, as it has been found from experience that they are necessary to prevent cracks. Struts will be used as shown, and door openings left in each buttress, with connecting slab, forming a passageway entirely through the dam.

Buttress flanges will be made with an overhang of 18 in. or about equal to the depth of slab. This is a little over the economical amount but inasmuch as it will be found later that the minimum thickness of the outer edge of the overhang must be about 16 in. in order to support the forms, this figure will be used, as it gives a proper proportioning. As a check, the shear should be computed at the centre of the flange, using about 50 lb. per sq. in. This will be found to check closely with the design given. The same forms will be used throughout, so the overhang will remain constant.

Slab.—Using a minimum of 10 in. at the top, the required thickness at elevations 2.0, 14.0, and 26.0 are computed by equation (b) and found to be 22, 19 and 14½ in. respectively, allowing 2 in. for protection. At elevation 2.0, however, the depth is 37 ft.; hence the shear, as a measure of diagonal tension, will control. This may be taken at 60 lb. per sq. in., a high value, which is permissible because the slab is so deep in comparison to its span that arching will doubtless occur. Hence

$$d = \frac{62.5 \times 12.16 \times 37}{2 \times 12 \times 60 \times \frac{7}{8}} = 22 \text{ in.} + \text{protection} = 24 \text{ in.}$$

and the slab will be made 24 in. thick.

The steel may now be computed from equation (c) which reduces to $S = 6.95\,d \div x$ if we use ¾-in. square bars. These bars are used as they will give a reasonable spacing (4 in.) at the bottom of the slab and may be used throughout with very little waste. It is a poor plan to use bars of different sizes in the deck, as there is a possibility of the bars being placed incorrectly. It is also preferable to make the change in spacing at the lift levels where the forms will be changed.

At el. 2	effective depth = 22 in.	x = 37 ft.	and S = 4.1 in.
" " 14	" " = 17.0 "	= 25 "	= 4.7 "
" " 20	" " = 14.75 "	= 19 "	= 5.4 "
" " 26	" " = 12.5 "	= 13 "	= 6.7 "
" " 32	" " = 12.25 "	= 7 "	= 12.0 "

Plotting these results we obtain the curve shown in Fig. 8, from which the spacing of the bars is taken as indicated.

Spacing bars ½ in. square, 36 in. on centres, will be used throughout the slab to hold and secure the reinforcing bars at the proper spacing, and will be lapped 2 ft. into each "lift" of the slab to tie the sections together.

It now remains to check the buttress design for shear and compression, determine the foundation pressure and design the footings.

The horizontal water pressures may be found from the formula $wx^2 \div 2$, which amounts, divided by the area of the buttress section at elevations 26.0, 14.0, and 2.0, give 22, 44 and 61 lb. per sq. in. respectively, which stresses are within the allowable.

Foundation Pressure.—Fig. 9 shows the graphical construction for determining the base pressure. The weights of the slab, flanges, and sections of the buttress are first computed, allowing 150 lb. per cu. ft. for the concrete. The centre of gravity of each section is then determined as shown, and the line of action of the entire weight of the dam is determined by taking moments about the toe. Thus:

	Weight.		Moment about toe.
Walk	6,800 lb.	× 7.25 =	49,000
Top lift buttress	18,100 "	× 10.5 =	190,000
Middle lift buttress	50,700 "	× 15.0 =	760,000
Bottom lift buttress	91,600 "	× 20.17 =	1,840,000
Slab	163,200 "	× 30.25 =	4,950,000
Flanges	51,600 "	× 25.75 =	1,328,000
Total	382,000 "	Tl. moment =	9,117,000

Distance from lower toe to line of action = 9,117,000 ÷ 382,000 = 23.9 ft.

The resultant water pressure per bay, which acts one-third up the inclined slab and at right angles thereto, (note that the slope of the front face of slab is about 43°) is found

$$\text{to be } \frac{62.5 \times 37}{2} \times 54 \times 15 = 935{,}000 \text{ lb.}$$

Combining this with the total weight of dam, as shown, the resultant is found to cut the base 0.5 ft. downstream from the centre. The total weight of dam plus 935,000 × cos 43° (or 684,000 lb., the vertical component of the water pressure) gives the total normal pressure on the base of 1,066,000 lb. Using the well-known formula,[1]

$$p = \frac{P}{l}\left(1 \pm \frac{6b}{l}\right)$$

where p = pressure on base in lb. per lin. ft.
P = total vertical load in lb.
l = length of base in ft.
b = distance resultant pressure to centre of base in ft.

we get an equivalent uniform load of 22,200 lb. per lin. ft. and p (max.) = 23,600 and p (min.) = 20,800 lb. per lin. foot.

As the width of buttress is 16 in. this represents a maximum compressive stress on the buttress of 23,600 ÷ (12 × 16) = 123 lb. per sq. in., which is entirely satisfactory. A similar computation for elevations 14.0 and 26.0 will also give results well within the limit of 300 lb. allowed.

The resulting pressure on the base with the water level at elevation 24.0 is also shown.

Footings.—A cross-section of the footing is shown in Fig. 7. It is designed as a simple cantilever footing having a width sufficient to transmit the load from the buttress to the soil at a reasonable unit foundation pressure. Thus, if we assume the width of cantilever as 10.5 ft. the load will be 2,250 lb. per sq. ft. The exact distribution of the foundation pressure is indeterminate and the unit pressure directly under the footing will probably be in excess of the above figure, but it is thought that this represents a safe design for the footing. The thickness of the cantilever next to the buttress will be controlled by shear, which may be taken at 50 lb. per sq. in., giving a required thickness of 2,250 × 4.58 ÷ 12 × ⅞ × 50 = 19½ + 2½ in. protection = 22 in.

The bending moment will be

M = (2,250 × 4.58 × 4.58) ÷ 2 = 23,600 ft. lbs.

From the formula $A = M \div f_s jd$; with $f_s = 14{,}000$, $f_c = 500$, $n = 15$, we have $j = 0.864$ and

$$A_s = \frac{M}{1030d} = \frac{23{,}600}{1030 \times 19\frac{1}{2}} = 1.17 \text{ sq. in. per ft.}$$

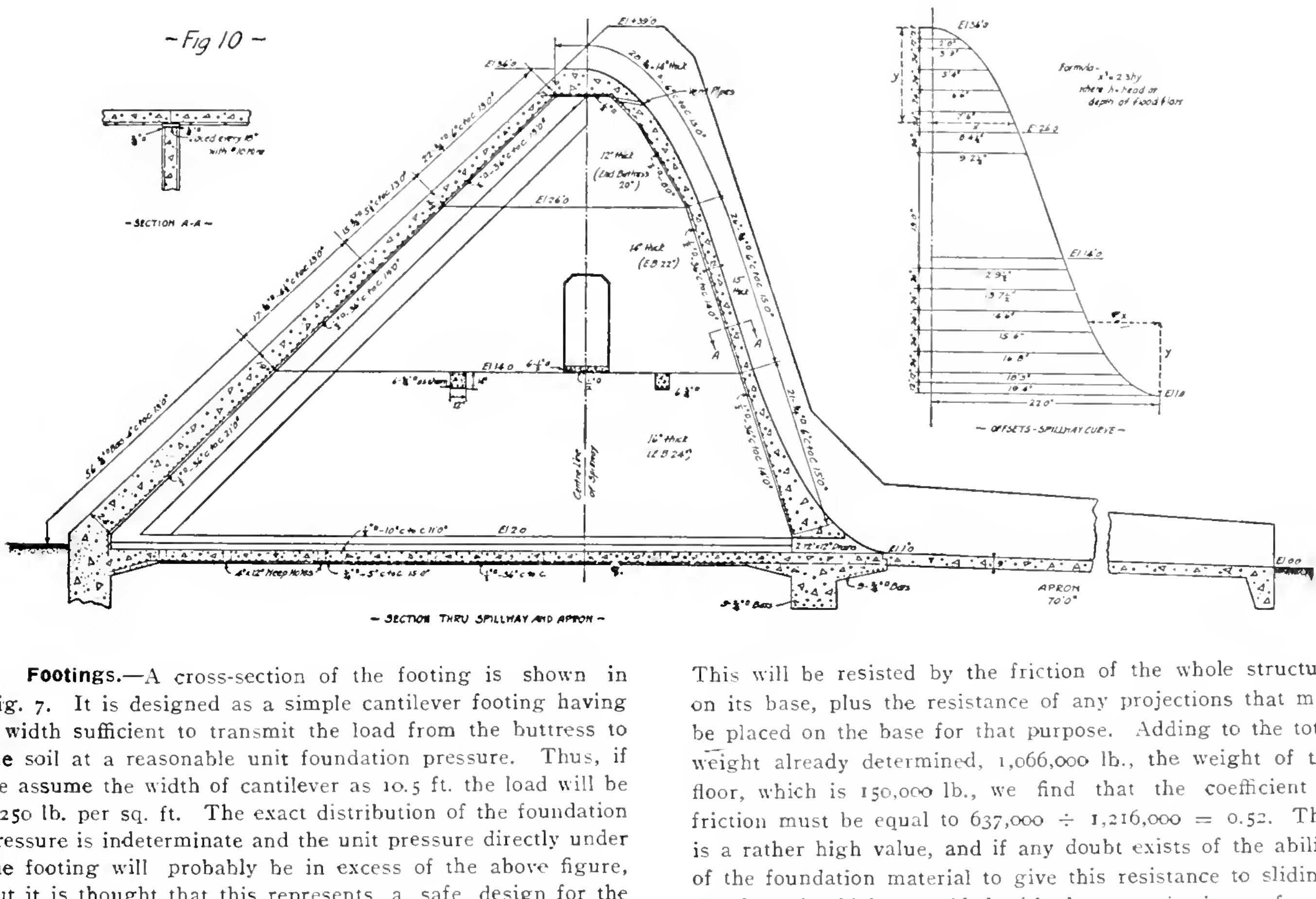
or ¾ in. square bars, 6 in. centre to centre, will be required.

The points where the raises in the footing may be made so that the shear may not exceed 50 lb. can be found by drawing a line from the edge of the buttress at the top of the footing to the centre of steel at the edge of the cantilever. This gives a convenient raise of 6 in. with an offset of 18 inches.

The slab covering the space between the ends of the footings will be computed as a continuous beam with a span of 15 — 10.5 = 4.5 ft. The maximum load that could come on this slab would occur on the assumption that the foundation load is uniformly distributed over the entire foundation. This assumption would give a load of 23,600 ÷ 15 = 1,570 lb. per sq. ft., and the bending moment in the slab would be M = (1,570 × 4½ × 4½) ÷ 12 = 2,650 ft. lb., requiring an area of steel A_s = 2,650 ÷ (1,030 × 8½) = 0.30 sq. in. per ft., which can be obtained by using ½-in. square bars 10 in. centre to centre.

Stability Against Sliding.—The horizontal component of the water pressure will be 935,000 × sin 43° = 637,000 lb. This will be resisted by the friction of the whole structure on its base, plus the resistance of any projections that may be placed on the base for that purpose. Adding to the total weight already determined, 1,066,000 lb., the weight of the floor, which is 150,000 lb., we find that the coefficient of friction must be equal to 637,000 ÷ 1,216,000 = 0.52. This is a rather high value, and if any doubt exists of the ability of the foundation material to give this resistance to sliding, the dam should be provided with base projections of sufficient size to resist the unbalanced thrust. The 4-ft. cutoff wall, shown in Fig. 10 at the downstream toe, will aid in resisting sliding, but should not be counted on to do so as its function is simply to prevent possible backwash from undermining the floor.

Spillway.—The spillway design is given in Fig. 10. The formula used to compute the spillway curve has already been stated and it was also stated that the design of the rollway slab was largely a matter of judgment. The other features



[1] See Baker's "Masonry Construction," p. 473.

of the design are identical with those already discussed, and no further computations will be made.

Forms.—Wall forms will be built in panels, as shown, the area of the panel being determined by the fact that, even where derricks and cable-ways are available, conditions frequently arise that require the manhandling of forms; hence they must be within the lifting capacity of the number of men that can be conveniently grouped around them for that purpose. For this reason no form will exceed 800 lb. in weight.

All forms will be designed to resist the loadings due to pressure of water in the concrete for the full heights of each lift.

Stresses used will be based upon the ultimate unit stresses recommended by the Association of Railway Superintendents with a safety factor of three, which is ample for temporary work of this character.

INTERNATIONAL ENGINEERING CONGRESS, 1915.

In connection with the Panama-Pacific International Exhibition which will be held in San Francisco in 1915, there will be an International Engineering Congress, in which engineers throughout the world will be invited to participate.

The congress is to be conducted under the auspices of the following five national Engineering Societies: American Society of Civil Engineers, American Institute of Mining Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and The Society of Naval Architects and Marine Engineers.

These societies, acting in co-operation, have appointed a permanent committee of management, consisting of the presidents and secretaries of each of these societies, and eighteen members resident in San Francisco.

The committee has effected a permanent organization, with Prof. Wm. F. Durand as chairman, and W. A. Cattell as secretary-treasurer, and has established executive offices in the Foxcroft Building, 68 Post Street, San Francisco.

The ten members of the committee, consisting of the the presidents and secretaries of the five national societies, will constitute a committee on participation, through whom all invitations to participate in the congress will be issued to governments, engineering societies, and individuals.

The honorary officers of the congress will consist of a president and a number of vice-presidents selected from among the most distinguished engineers of this and foreign countries.

The papers presented at the congress will naturally be divided into groups or sections. During the congress each section will hold independent sessions, which will be presided over by a chairman eminent in the branches of engineering covered by his section.

The scope of the congress has not as yet been definitely determined, but it is hoped to make it widely representative of the best engineering practice throughout the world, and it is intended that the papers, discussions and proceedings shall constitute an adequate review of the progress made during the past decade and an authoritative presentation of the latest developments and most approved practices in the various branches of engineering work.

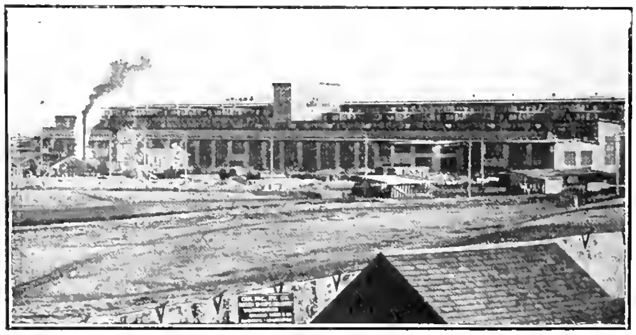
The papers, which will be collected and published by the congress, should form an invaluable engineering library, and it is intended that this publication shall be in such form and at such cost as to become available to the greatest possible number.

CANADIAN PACIFIC RAILWAY SHOPS AT OGDEN, ALBERTA.

The Canadian Pacific Railway has recently put in operation near Calgary, Canada, a large shop plant of more than ordinary interest by reason of its size, its complete and modern character, and the speed with which it was created.

The work was designed and built in its entirety by Westinghouse. Church, Kerr & Company, consulting and constructing engineers, of Montreal and New York, working under the direction of Mr. J. G. Sullivan, chief engineer of the western lines of the Canadian Pacific Railway, and Mr. N. E. Brooks, divisional engineer.

The shop location is at Ogden (named in honor of a vice-president of the railway), and is 4½ miles from Calgary and about 2,250 miles from Montreal. Its distance from those sections of the country where the greater part of the construction materials, machinery and equipment were produced constituted the first and one of the most important problems. A second important problem arose on account of the construction season being extremely short, owing to the high latitude, frost remaining in the ground until about April 1st and returning with snow as early as October 1st. A third very important problem was the comparative scarcity of labor in the Canadian North-West, this condition being greatly aggravated during the late summer months, when harvesting begins and all labor markets are practically drained of men.



Main Building From West, Showing Blacksmith and Boiler Shop Bays.

Plans had, therefore, to be drawn, materials ordered, deliveries made and complete field organization perfected so that the shops could be closed in between April and December 1st, and sufficiently heated so that inside work could be continued after cold weather had set in. How this was done will be seen by the following progress diagram:—

The shops consist in general of:—

Main locomotive shop (including erecting, machine, blacksmith and boiler shops).

Tender and wheel shop.

Pattern shop and pattern storage.

Foundry.

Storehouse and office building.

Material platforms and scrap docks.

Oil-house.

Carriage repair and paint shop.

Freight car repair shop.

Planing mill.

Boiler-house.

1,260-foot yard crane.

Miscellaneous structures, including transfer table and pit for coach shop, main hoist, wells, and water-tower, and all service systems, such as drainage, sewers, fire protection, water supply, etc.

Main Locomotive Shop.—This building is designed to contain the erecting shop, machine shop, blacksmith shop, and boiler shop.

The erecting shop is of a transverse lift-over type, and contains thirty-five bays, each twenty-five feet between centres, and is 778 feet long by 75 feet wide. The entire area is served by two travelling electric cranes, carried on two levels. The 120-ton crane, furnished with two 50-ton trolleys, is carried on the upper level, and is used for transferring, wheeling and unwheeling locomotives and handling parts. One of the trolleys on this crane is equipped with a ten-ton auxiliary hoist for handling light material at a high hoisting speed.

Another ten-ton travelling electric crane operates at high speed, and serve the entire area of the erecting shop for handling material in that shop and tranferring same to the blacksmith shop and machine shop. The machine shop and the boiler shop are located in adjacent bays on either side of the erecting shop.

Provision is made on the crane columns in the erecting shop for attaching portable jib cranes for use in dismantling and erecting material on the front ends of locomotives. These cranes are placed where desired by means of the overhead travelling electric cranes.

Entrance for locomotives to the erecting shop is provided through four doors, located in the west side of the shop, two of these doors being located at either end.

For providing additional means for entrance of locomotives, six door openings are provided in the east wall of the machine shop, two of these being at the north end and four at the south end.

All of these entrance tracks are connected up with the erecting pits of the several stalls where they enter the building to permit of the locomotives moving into and out of the shop through these entrances should this movement become desirable or necessary.

The machine shop to contain heavy machine tools is located parallel with and adjoining the erecting shop on one side, and is 60 feet 9 inches wide and the same length as the erecting shop. A high-speed travelling crane of ten-ton capacity covers the entire area of this shop. Material can be brought into the shop through a door provided in the end of the building the material being brought up to the end of the machine shop by the travelling electric yard crane, which travels across the end and outside of the locomotive shop.

Space for the lighter machine tools is provided in a shop 60 feet 9 inches wide parallel with and alongside of the heavy machine shop and of the same length as that shop. An overhead trolley beam is provided on the bottom chord of the roof truss to permit of using a travelling electric trolley for handling material longitudinally in this shop. Provision has been made for a foreman's office elevated above the floor and having liberal glass surface in the walls so as to give the best possible view of the shop.

The blacksmith shop is located alongside of and parallel with the erecting shop on the opposite side from the machine shop. This building consists of two bays, each 332 feet long, 60 feet 9 inches and 50 feet wide, respectively.

Space is provided for heavy forging work, steam hammers, etc., in the building immediately adjoining the erecting shop.

The blacksmith shop will not be served by a travelling crane, but provision has been made for jib cranes to handle the material from steam hammers, forgings, etc.

In a building of lower cross-section alongside are located the furnaces, bolt headers and other blacksmith shop machinery. This portion of the shop is served by a trolley its full length to facilitate the longitudinal movement of material through the shop.

The space for the boiler shop is provided in a [illegible] bay building, alongside of and parallel with the erecting shop at the end of the blacksmith shop, 352 feet long and the same width as the latter shop.

That part of the boiler shop immediately adjoining the erecting shop is provided with a 40-ton travelling electric crane equipped with two 20-ton trolleys serving the entire area of the boiler shop for handling the boilers and other material.

The riveting tower is located between two of the roof trusses in the end of the boiler shop, with a 25-ton crane for serving the hydraulic riveter.

In the outer of the two bays of the boiler shop space is provided for a flue shop and boiler shop tools. The entire length of this space is served by a 3-ton overhead travelling trolley for handling material through the shop. Space for a flue rattler is provided immediately outside of and adjacent to the low bay of the boiler shop.

An entrance track is provided through the outside wall of the boiler shop, on which boilers or other equipment going to this department can be delivered on cars under the travelling crane for unloading or may be loaded out for shipment in the same way. This facilitates the handling of boilers from steam shovels, pile-drivers, Lidgerwoods, etc.

Jib cranes are provided for serving the individual machines in the boiler shop where such service may be necessary.

Northwest View, Showing Roof Arrangements With Reference to Lighting of Erecting and Machine Shops.

The heating throughout is done by indirect fan system. For distributing the heated air underground concrete and tile ducts are used.

The general illumination consists of Cooper-Hewitt lamps, with circuit and plug boxes for extension loop cords. Provision has also been made for incandescent lighting circuits for individual lighting at machine tools where required, and for outlet boxes for connecting extension lamp cords to provide lighting for the interior of the locomotive boilers on the erecting floor.

Toilets, lavatories, and metal lockers are provided in the various departments of this shop.

A suitable system of piping is provided for distributing live steam, compressed air, fuel oil, and water for fire protection, drinking and hydraulic pressure.

Outlets for compressed air are provided in duplicate in the sides of each of the engine pits to supply compressed air for operating pneumatic tools.

In the main locomotive shop the electrical feeders from the power company's transmission lines are carried in underground ducts, bringing the current at the voltage delivered by the power company, namely, 2,200 volts, to a sub-station located adjacent to and immediately outside of the low machine bay, the transformers for stepping down to 440 volts being located in this sub-station. In this sub-

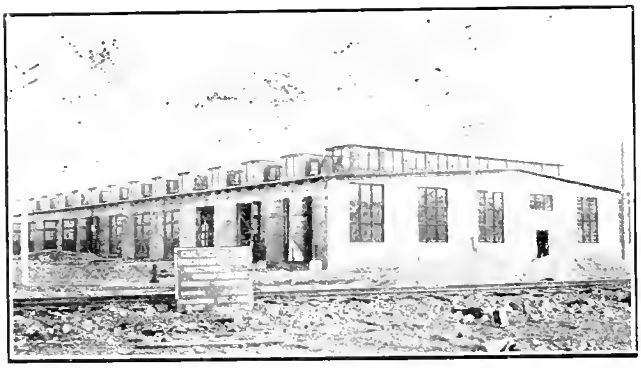
station two motor generator acts for supplying direct current are also located. The switchboard is also located in this sub-station for controlling the power and lighting circuits in the machine shop and for the tender shop and foundry. As far as possible distributing feeders are carried in conduit beneath the shop floor, thereby minimizing the amount of exposed wiring in the shops.

The building containing all of the above departments of the locomotive shop is constructed with structural steel frame carried on concrete foundations. The exterior walls up to the window-sill line are of concrete; above the window-sills of hollow tile, plastered.

Ample window area is provided in the side walls and in roof monitors and skylights so as to give sufficient natural lighting.

Good ventilation is obtained through ventilators in the monitors and skylights and by the use of swinging sash in the vertical walls.

With the exception of the blacksmith shop and a portion of the boiler shop, the floor throughout is constructed with a 1½-inch asphalt mastic wearing surface, which is underlaid with a rough concrete slab about six inches thick. In the blacksmith shop and a portion of the boiler shop the floor is of cinders.



Coach Repair Shop.

The roof sheathing is constructed of 2 x 4's, surfaced on one side and one edge and spiked together on edge, thus affording good fire-resistance qualities and materially reducing the heat losses. The roof waterproofing is four-ply tarred felt, pitch and gravel, with copper flashing. Suitable drain leaders are provided and connected into underground tiled drains to carry off the water from the roof.

The large skylight on the erecting shop bay is of steel bars, lead-covered with ribbed wired glass.

Tender and Wheel Shop.—This building is constructed with structural steel frame and with steel roof trusses, otherwise the general construction of the building is similar to that described for the main locomotive shop. It is an L-shaped structure, 263 feet by 80 feet wide, with L 180 feet long by 80 feet wide, and affords space for making repairs to locomotive tenders, steam shovels and other maintenance-of-way equipment.

That portion of the shop intended to receive the equipment to be repaired is spanned over its entire area by a 20-ton high-speed travelling electric crane equipped with two 10-ton trolleys.

Longitudinal tracks on 20-foot centres extend to the doors in the building wall.

A car-puller is installed for moving the equipment into and out of the shop.

A sufficient number of tracks extend through the rear wall of the building to facilitate the movement of material into the shop.

In the L portion of the building of lower cross section space is provided for steel tire wheel lathes, wheel and axle machinery and such other tools as are required.

A depressed track carried along the ends of the wheel storage tracks outside facilitates unloading and loading of wheels and axles.

The heating, lighting and service equipment is similar to that described for the main locomotive shop.

Pattern Shop and Pattern Storage.—Space for the pattern shop and pattern storage is provided in a separate building, located adjacent to the foundry, a fire-wall separating the pattern shop from the pattern storage.

The general construction of the building is the same as that of the other buildings—the roof of slow-burning mill construction. The structure is 162 feet long by 31 feet wide, is heated by the direct system, and lighted with keyless socket, marine type incandescent lamps. A sprinkler system is provided for fire protection.

Foundry.—The grey iron foundry building is 203 feet long by 80 feet wide, constructed with two bays. The frame is of structural steel, carried on concrete footings. The general construction is the same as that described for the other buildings, except that the floor is of the usual clay type used in foundries, and the roof over the cupola room is of corrugated asbestos.

The bay of higher cross-section is served over its entire length by a 10-ton high-speed travelling electric crane. Jib cranes, attached to building columns, are provided. These cranes are so arranged that they may be removed from one location to another if desired, being handled by the travelling electric crane. In the side bay of lower cross-section space is provided for core-making and shop moulding floor.

The charging floor for the cupola is located in the centre of the lower bay.

Heating is by the indirect fan system, with underground tile and concrete hot-air ducts. For general illumination flaming arcs are used in the high bay and ordinary arcs in the low bay, with outlet boxes for extension lamp cords.

Toilets, lavatories, and conveniences for the men are provided; also steam, air, and water service for fire protection and drinking purposes.

The location of this building alongside of and parallel with the travelling electric yard crane enables the unloading of scrap and pig-iron to be taken care of by the yard crane. This close proximity of the foundry to the yard crane also reduces to a minimum the handling of the castings from the foundry to storage, to the main shop, or in loading for shipment.

Storehouse and Office Building.—This building is 252 ft. 6 in. long by 60 ft. wide. One end of the building for a length of forty feet is carried up three stories, and contains offices on the second and third floors and a fireproof vault. The remainder of the building, for storehouse purposes, is two stories high and contains electric elevator, platform scales, material bins and shelving.

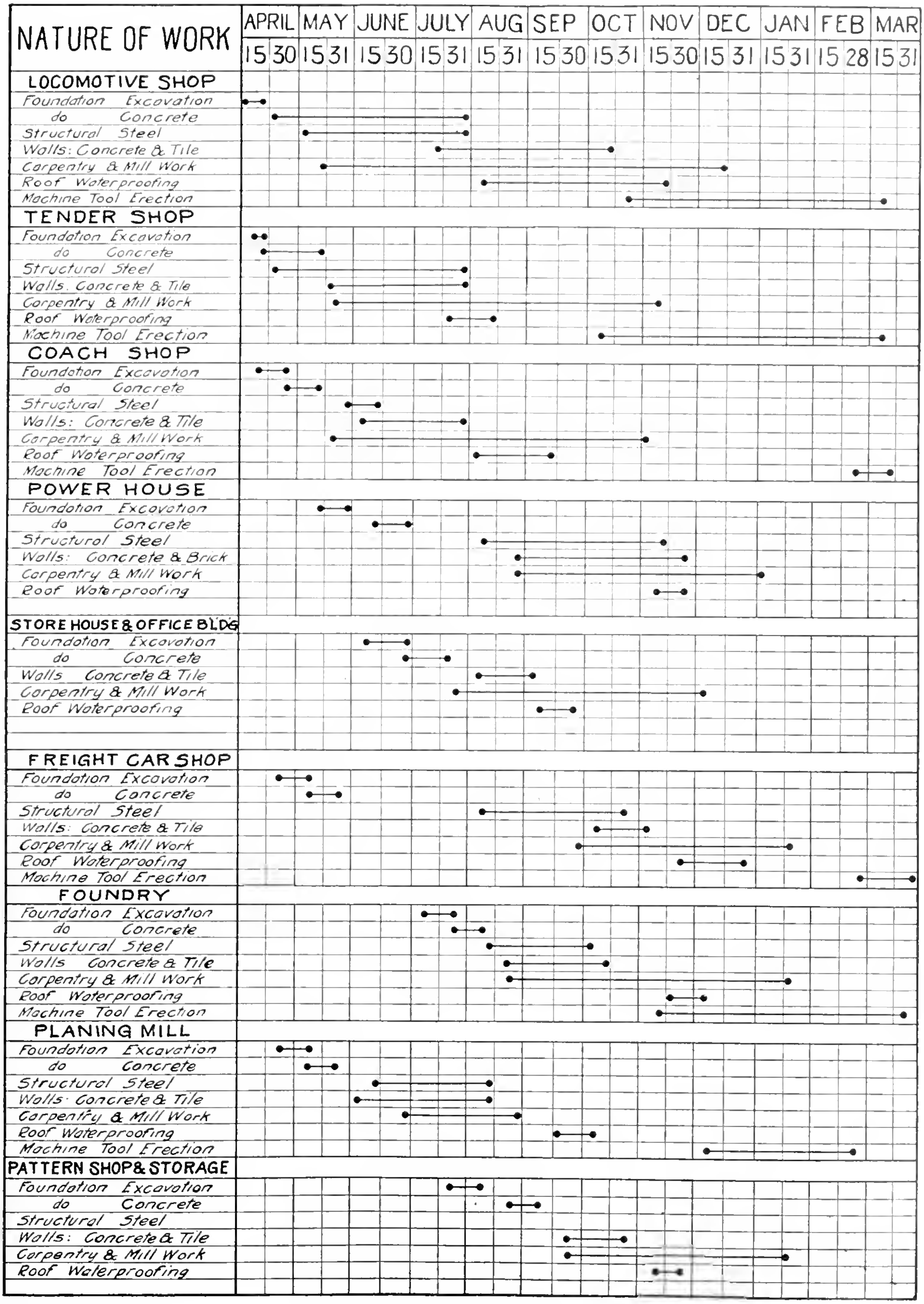
The wall are constructed of hollow-tile blocks on concrete foundations. The framing is of heavy timbers, with roof sheathing of two by fours, surfaced on one side and one edge, and spiked together on edge. The foundations are carried up to bring the floor of the storeroom to car door height.

The necessary toilet and lavatory facilities are provided. The offices are heated by direct radiation, the remainder of the building being heated by the indirect system. The lighting is by incandescent lamps. Fire protection is by automatic sprinklers.

The ground floor of the storehouse has an 1½-inch asphalt mastic wearing surface. The other floors throughout the building are of wood.

The window arrangement is such as to best accommodate the material bins and shelves without interference with good lighting.

The storehouse is located parallel with the main locomotive shop. The space between these two bu[illegible] is spanned by a high-speed travelling crane, which [illegible] be



C.P.R. Shops, Calgary—Progress Record.

utilized to handle all heavy material to and from the cars from the storage space that is provide between the storehouse and the erecting shop. The use of this crane practically eliminates manual handling of heavy material, and permits of handling numerous small parts in quantities when contained in suitable receptacles.

Interior of Planing Mill.

Material Platforms and Scrap Dock.—A material platform, 90 feet wide and about 350 feet long, abuts one end of the storehouse. This platform is also carried along either side of the storehouse, where it is 15 feet wide. It is constructed of concrete retaining walls, filled in with earth, and a topdressing of cinders covers the fill, except alongside of storehouse, where plank covering is laid. The platform extends to and along the sides of the oil-house.

Oil-house.—For storing and distributing oil a separate building is provided convenient to, but located far enough away from, the storehouse and other buildings to eliminate the fire risk. It is constructed with tile walls (plastered on the exterior) on concrete foundations, with a concrete basement at one end for the tanks which contain the oil, for local distribution. The roof is of reinforced concrete slab, as is also the floor of the pump-room over the basement. That part of the building used for storing oil in barrels has a cinder floor. The pump-room is partitioned off with a brick wall, carried up to make a fire-wall

Ten oil tanks, with measuring pumps, are installed, and provision is made for conveniently emptying the oil from barrels into the tank in the basement.

The oil-house basement is heated by the direct system to the high temperature necessary to render the oil fluid during extreme cold weather, the direct system being also used to heat the rest of the building. The lighting of the building is with keyless socket marine type incandescent lamps. Fire protection, including sprinklers, is installed.

Coach Repair and Paint Shop.—The building containing these departments is 362 feet long by 146 feet wide, having fifteen tracks on 24-inch centres. It is constructed with hollow building tile carried on concrete foundation. Heavy timber posts support the roof, which is of slow-burning mill construction. Otherwise the construction is the same as that described for the main shop building.

Space is provided along one side of the building for varnish room, upholstering, office, sub-store, paint storage, heating plant and air-brake repairs.

When necessity arises for increased shop capacity in this department it is proposed to obtain such increase by the erection of another shop on the opposite side of the transfer table.

Heating is by the indirect fan system, with underground concrete and tile ducts. Lighting is by incandescent lamps. Compressed air, steam and water service, including fire protection and automatic sprinklers, are provided Toilets, lavatories, and conveniences for the men are also supplied in this shop.

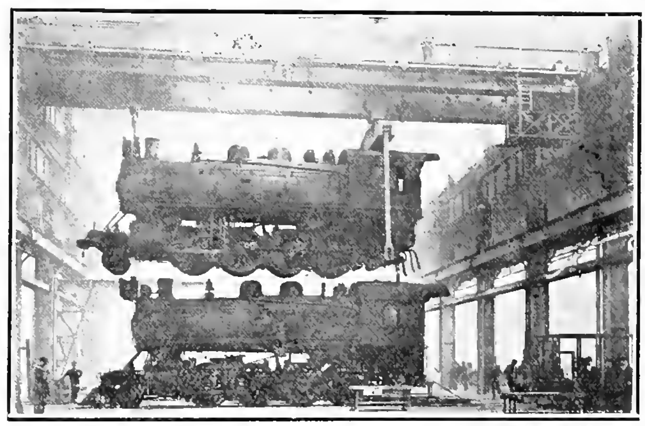
Freight Car Repair Shop.—This building is 231 feet wide by 303 feet long, and contains eight repair tracks spaced in pairs, with industrial track between each pair of repair tracks. A tile wall partitions off the shop, fifty feet wide along one side, which will contain the blacksmith forges, tools, heating plant, foremans office, toilets, and lavatories.

The building is of structural steel frame, with tile walls, plastered on the outside, with saw-tooth roof construction. The general construction of the building otherwise is the same as that of the other shop buildings. An overhead trolley beam is provided to permit of handling timbers with a trolley into the shop.

Compressed air, steam and water service piping, and fire protection, including automatic sprinklers, are supplied. Heating is with the indirect fan system, with underground concrete and tile ducts. Lighting is by 100-watt Tungsten lamps.

The location of this building alongside of the lumber yard permits of handling lumber so that it can be passed through into the shop without rehandling.

Planing Mill.—This building is 303 feet long by 80 feet wide, and contains the woodworking machinery. The frame is of structural steel, carried on concrete footings. The general construction of the building is the same as that of the other shop buildings. A track extends through the building longitudinally to permit of movement of material in at one end to the various machines and out through the opposite end with the minimum amount of handling. The



Interior of the Locomotive Shop, Showing 120-Ton Locomotive Crane.

building is located so as to be convenient to the passenger car shop and the freight car shop. The lumber yard is located back of and at one end of the planing mill.

Suitable piping has been provided for distributing compressed air and water. The fire protection system includes automatic sprinklers.

Provision is made for toilets, lavatories, and metal lockers for the men employed in this department.

Heating is by the indirect fan system with galvanized iron heating ducts. Lighting is by mercury vapor lamps.

Boiler House.—This building contains sufficient space for 21,000 horse-power water tube boilers that are required to provide steam for heating the shops and for other purposes for which steam is required throughout the shops. The building is constructed with brick walls carried on concrete foundations, with steel roof trusses and supports for coal bunkers. The chimney is of reinforced concrete, 200 feet high, with a minimum diameter of nine feet.

The overhead coal bunker for each boiler is divided by a reinforced concrete partition into two compartments to provide for storing and burning two kinds of coal. An overhead storage bin for ashes is provided, from which bin the cinders can be discharged by gravity into cars alongside of the building. A concrete dumping hopper is provided outside for dumping coal from cars. A pivot steel elevator raises and discharges the coal into the overhead bunker. A skip-bucket, with electric hoist, handles the ashes into the ash-bin.

The boiler units are 350 horse-power rating, and are set in three batteries of two each. Five of the boilers are equipped with chain grate stokers. The sixth boiler has the shaking grates to burn shavings and other planing mill refuse.

Space is also provided for three electrically driven air-compressors, each of a capacity of 1,500 cubic feet of free air per minute. Only two of these compressors are installed at this time.

Transformers and distributing panel are located in this building for transforming and distributing light and power current to the shop yard, freight car shop, planing mill, and coach repair shop. There is no direct current apparatus in this station.

Provision has been made for two incoming 2,200-volt lines, one of 2,000 k.w. and the second of 1,000 k.w. capacity for breakdown service.

The steam required for the steam hammers and other shop purposes during the summer time can be supplied by one boiler. The boiler capacity provided will afford one spare boiler during the extreme weather conditions when the maximum steam demand occurs.

Yard Crane.—A yard crane runway, 1,260 feet long, extends from the west line of the locomotive shop, and carries a 10-ton high-speed travelling electric crane with 80-foot span, serving the material yard and a portion of the storehouse platform and scrap dock. One of the storehouse tracks extends through under this crane, resulting in giving ample space for the storage of material alongside of the storehouse, foundry and locomotive shop. By this arrangement heavy material can be unloaded, stored, and rehandled to the shop or loaded out again by the crane for shipment, practically eliminating manual labor in the handling of all heavy material.

Miscellaneous Structures.—The transfer table for serving the coach shop is 75 feet long, of 150 tons capacity, equipped with electric motor, with concrete transfer table-pit 400 feet long, extending out far enough at either end of the building for providing entrance and egress at both ends.

The mess building is 269 feet 6 inches long by 31 feet 10 inches wide, of wooden frame construction, covered outside with sheathing, building paper and siding, and sealed on the inside with metal sheathing. It has a concrete floor, and contains a dining-room and lunch room for the workmen and a dining-room for the officials, together with kitchen and pantry. Sixty feet of the length of the building is carried up two stories to provide an apprentice schoolroom and quarters for the help. Heating is by the direct system and lighting with incandescent lamps.

There are also two small buildings located near the freight repair tracks for blacksmith shops and workmen's tools, and in one of them is a small toilet and [illegible]. Dry kiln material bins, plate and iron racks, coal and [illegible] are also provided.

For obtaining water for shop purposes there have been put down two eight-inch wells equipped with electrically operated pumps. To supplement this supply and to provide a main source of supply for fire protection the city of Calgary has brought down into the shop site to a point midway the length of the main shop building on the west side a 10-inch cast-iron water main. The shop service and fire lines are connected onto this main and into a steel tank of 125,000 gallons capacity, which is erected on a 70-foot steel tower, principally for use in connection with automatic sprinklers in the various buildings where these are installed. A complete fire protection system has been put in, with hydrants distributed about the shop yard.

The sewage system in the shop yard may be divided into the sanitary and storm sewers. The city of Calgary is furnishing the main sanitary sewer, beginning at the east line of the freight car shop and extending to the eastern boundary of the shop property. All the sanitary sewage lines from the various buildings are connected into this sewer. Storm sewers are provided where necessary to carry off the roof water from the buildings where the roof construction is such that this cannot be discharged on to the ground.

The location of the shops is about four and one-half miles east of Calgary, practically on the open prairie, and on the beginning of construction arrangements had to be made to house and board on the shop property a considerable quantity of labor. To this end, frame bunk-houses were built with two tiers of bunks on each side of the building, eight bunks long, each house having a capacity of 32 men. Stoves were placed in the centre aisle and benches along the sides of the lower tier of bunks. On the coming of summer and as the labor forces were increased some of the men were housed in standard 12 x 14 wall tents, which accommodated four men each. A large mess-room and kitchen and store-room space was also fitted up with a capacity of feeding about 400 men at one time. Great care was exercised throughout the work in keeping the camp in a sanitary condition. This work was largely under the direction of doctors, who visited the camp each day to take care of all sickness, and an arrangement was also made whereby those who were employed on the work voluntarily contributed a small amount from their wages for the services of these doctors. This amount also included hospital service when necessary. Due to this care there was very little sickness on the job.

As there were no accommodations for men with families near the shops the railroad company put into temporary service a train to carry the men back and forth from Calgary, and several hundred men went back and forth on this train each day. This arrangement helped the situation considerably, especially as the season advanced and all kinds of skilled and unskilled labor became more difficult to obtain. A standing order was placed through several labor agencies in Calgary to send men daily to the job. As the work neared completion the bunk-houses and mess-house previously mentioned were turned over to the railroad to take care of their own men, who were at that time living in cars on the property. This, of course, released the cars and permitted their use at other points.

The progress schedule will show the prosecution of the work, but it should be again pointed out that it was not possible to break ground until April 1st, 1912, and by March 17th, 1913, the locomotive shop was in full operation. When the magnitude of the work is considered, as also its distance from the larger centres, it will be appreciated that a record for prompt performance has been established.

PHŒNIX BRIDGE AND IRON WORKS COMPANY

The Phœnix Bridge and Iron Works Company is making a new issue of bonds and stock this week, through the Quebec Savings and Trust Company. This stock has already been underwritten, and is now being distributed to the public. The offering consists of $750,000 of 6 per cent. first mortgage bonds, and of $800,000 of common stock. The bonds are being offered at 96 per cent. of par, and the stock at $50 per share. The offering is being made simultaneously in London and in Canada. Approximately $450,000 of the bonds and $405,000 of the stock have been taken firm. A new company has just been incorporated at Ottawa with a capitalization of $1,500,000. This company in every way takes the place of the company which has heretofore operated under the same title. After the present issue has been accomplished, there will remain in the treasury to provide funds for future expenses and for the general purposes of the company, $700,000 of the common shares of the company. All the bonds will have been issued.

The Phœnix Bridge and Iron Works Company has a plant situated in the centre of the manufacturing district of Montreal, where shipping facilities are all that could be desired. The concern manufactures and erects structural steel for bridges and buildings. The cost of delivery, owing to the central location of the concern, is smaller than in the case of most other companies. Operations have now been carried on satisfactorily since 1898, and save for an occasional year, earnings have shown a fairly constant increase, beginning with $51,000 in 1898 and progressing gradually to upwards of $600,000 during the past couple of years. The land owned by the company allows of an expansion to the works. The assets of the company, at the end of last year, including $25,000 which is being provided for improvements, amounted to $1,400,000, while total liabilities were but $57,000. This leaves a surplus of $1,243 against the present bond issue of $750,000.

Mr. James W. Pyke is president of the company, and Mr. T. Palmer Howard is general manager.

ABSENCE OF ROADS IS ECONOMIC LOSS

The improvement and maintenance of good roads in the rural districts is a vital problem in all parts of Canada. Inevitably, perhaps, the phenomenal development of railway and waterway navigation has largely overshadowed the necessity that exists for properly built waggon roads. However, it is steadily being more fully realized that the absence of such roads causes an economic loss of great importance to every citizen, and especially those of the rural districts.

Scientific progress is being made in many parts of Canada. The government of Ontario is spending large sums on roads in New Ontario. New Brunswick is enacting "good roads" legislation; and Saskatchewan, where railway development during the past few years has been phenomenal, is carrying out a comprehensive "good roads" policy.

Saskatchewan has appropriated $1,200,000 for highway improvement work during 1913. This is merely a continuation of the work commenced in 1905, and each year since then the government has expended from $200,000 to $700,000 a year on roads and bridges. The work has been carried out under the supervision of a board of highway commissioners, and assistance is granted through them to municipalities under certain carefully defined conditions, states Conservation. This assistance is confined to the building of bridges and trunk roads. The old statute labor system is discouraged as being uneconomical and inefficient.

In view of the scarcity of gravel and stone in many parts of Saskatchewan, extensive experiments have been carried out at provincial expense to ascertain the best means of constructing clay roads. It has been found that Saskatchewan clays burned at comparatively low temperatures produce an excellent surfacing material for graded roads. Owing to the reddish color of this burned clay these roads are known as "the red roads of Saskatchewan." Their cost, where underdrainage is not necessary, has been found to be from $2,000 to $2,500 a mile. This includes the cost of burning the surface clay. Where tile drainage of the grade is essential, the cost is increased by from $1,000 to $1,500 a mile. It is claimed that these roads stand up well under prairie conditions.

Another class of road that is being experimented with in Saskatchewan consists of a specially prepared clay grade covered with asphalt. If suitable to the conditions, such a road should prove popular in the smaller towns and villages.

INSTITUTION OF CIVIL ENGINEERS.

Many of our readers will be interested in learning that Col. H. N. Ruttan, city engineer of Winnipeg, as a result of the ballot for the election of officers for the next session of the Institution of Civil Engineers has been included. The list of gentlemen whose names appear as eligible for election is as follows: President, Mr Anthony George Lyster; vice-presidents, Mr. Benjamin Hall Blyth (Edinburgh), Mr. John Strain (Glasgow), Mr. George Robert Jebb (Birmingham), and Mr. Alexander Ross (London); other members of council, Mr. John A. F. Aspinall (Liverpool), Mr. John A. Brodie (Liverpool), Mr. William B. Bryan (London), Colonel R. E. B. Crompton (London), Mr. J. M. Dobson (London), Sir Hay Frederick Donaldson (London), Mr. E. B. Ellington (London), Mr. W. H. Ellis (Sheffield), Mr. W. Ferguson (Australasia), Sir Maurice Fitzmaurice (London), Sir John Purser Griffith (Dublin), Mr. C. A. Harrison (Newcastle-on-Tyne), Mr. Walter Hunter (London), Mr. Harry E. Jones (London), Sir Thomas Matthews (London), Mr W. H. Maw (London), Mr. C. L. Morgan (London), Mr Basil Mott (London), Mr. A. M. Tippett (South Africa), Sir Philip Watts (London), Mr W. B Worthington (Derby), Mr. Dugald Clerk (London), Mr. Robert S. Highet (India), Mr. Edward Hopkinson (Manchester), Mr. Frederick Palmer (London), and Col. H. N. Ruttan (Winnipeg).

LARGE STEAM PLANT.

Contracts for a steam plant of 60,000 k.w. capacity have been placed recently in New York by Messrs. Guggenheimer & Company, New York, for the Chile Exploration Company. The equipment at present comprises four 10,000 k.w. Siemens generators coupled direct to four 14,300 P. S. Zoelly steam turbines of Escher Wyss & Company manufacture, Zurich. These units will run at 1,500 r.p.m. when working with steam of 170 pounds pressure and 325° Centigrades superheat. Escher, Wyss & Company, Montreal, who are attending to the American business of their works, Zurich, have secured this order against competition from the foremost American and European makers on the strength of the low steam consumption of their turbine.

The plant is to be installed in Chile, and the power used for electric smelting of copper ore. The transmission line, which is of 200 miles length, will be for 110,000 volts pressure. Messrs. Siemens, Schuckert Werke have been awarded the contract for the whole of the electrical equipment.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD
MARINE AND MINING ENGINEER, THE SURVEYOR,
THE MANUFACTURER, AND THE
CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, MAY 29, 1913. No. 22

CONTENTS OF THIS ISSUE.

OIL ENGINES FOR MARINE SERVICE.

While Canada may not, perhaps, stand out conspicuously as a country that has shown very great development along shipbuilding and marine engineering lines, there has doubtless during the past few years been a great impetus given to the shipbuilding and marine engine industry in this country, and there is every reason to believe that this will continue to go on indefinitely. For that reason it is interesting to note the changes that have recently taken place, so far as the adaptation of the oil engine to marine purposes is concerned.

A report just issued by the committee of Lloyds' Register calls attention to the fact that the British Admiralty during the past year have placed contracts for marine oil engines greater in power than ever anything attempted. This report states that there are Diesel oil engines now being built for thirty-four marine vessels, these vessels ranging in tonnage from two to two thousand tons, and the engines of various types ranging in power from 750 to 120 brake horse-power per set. This report states that from January 1st, 1910, to the present time there have been completed in the United Kingdom under the survey of the society fifteen oil-carrying vessels and nineteen other vessels constructed with oil-fuel bunkers. This will give our readers some idea of the work that is going on looking toward replacement of coal by oil for marine purposes. It furthermore states that five large engineering firms on the Clyde are now in a position to make Diesel oil engines for the largest class of ocean-going ships. All along the line the demand for steamers with oil fuel furnaces is increasing very greatly. Not only in Great Britain, but in other countries, this subject has been given a great deal of attention. Russia stands out notably as a country in which this work has been attempted in the most vigorous manner, and altogether it looks as though the oil engine, so far as its application to marine purposes is concerned, is quickly coming into its own.

This development is not without significance and interest for those connected with the shipbuilding industry in Canada, as signs are not altogether wanting which point to bigger things being accomplished by the yards in Canada in the days that are to come.

THE COMMERCIAL TREND OF THE PRODUCER GAS POWER PLANT.

In investigating general problems that relate to the fuel resources of the country and in testing fuels belonging to or for the use of the Government, the Bureau of Mines of the United States has given considerable attention to the efficiency and economic value of producer-gas power plants. Its engineers during the past eight years not only have shown a very low fuel consumption per horse-power hour for these plants, but have demonstrated conclusively the possibility of utilizing commercially low grades of bituminous coal, lignite, and peat in plants properly designed for the use of those fuels. The anthracite plant has been recognized as a commercial possibility for several years, although the cost of the fuel used has in general restricted these plants to comparatively small units.

The commercial development of the producer-gas power plant in America has been largely within the past six or eight years. The feeling of doubt in the minds of many regarding the future of the industry has led the Bureau of Mines to publish in a brochure the results of

their investigations. This feeling of doubt was fostered by the extensive introduction of the steam turbine and the increased interest in the oil engine. During the past three years the belief of many who were formerly firm believers in the gas producer has been that this type of power has reached its height of development, and that from a commercial standpoint it can no longer be regarded as a complete success.

The results of these investigations and the facts gleaned from an inspection of the summaries and charts presented are far from revealing the condition thought to be the case by those who have regarded the immediate downfall of the producer as inevitable.

It is probable that at the present time there are in the United States 900 or 1,000 producer gas-power plants, ranging in size from 15 horse-power to several thousand horse-power.

During the past three years the number of anthracite plants over 500 horse-power rating has increased 263 per cent., and the total horse-power represented by these plants has increased in the same period 242 per cent.

During the same period the number of bituminous-coal plants of 500 horse-power rating or less has increased 118 per cent., and the total horse-power represented by these small bituminous-coal plants has increased 89 per cent.

At the present time producer-gas plants representing nearly 85 per cent. of the total number of installations in this country are operating on anthracite.

Of the total horse-power listed, approximately 48 per cent. is derived from anthracite and nearly 52 per cent. from bituminous coal and lignite.

In 1909 the bituminous-coal plants averaged 12.5 times the size of the anthracite plants, but the introduction of the larger anthracite plants and of the smaller bituminous-coal plants makes the ratio for 1912 about 7.5 to 1.

The use of the small bituminous-coal producer is increasing, and an examination of the complete list of installations reveals several suction plants operating on bituminous coal. Their development is one of the most important steps in the producer field.

OTTAWA CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

Mr. Charles Warren Hunt, secretary of the American Society of Civil Engineers, sends us the following information in connection with the forty-fifth annual convention, which is to be held in Ottawa June 17th to 20th. In a recent issue we gave some information concerning this convention, and we are glad to be able to add to this, and trust that many of our readers will have the opportunity of visiting Ottawa during convention week:—

The headquarters of the society, secretary's office, etc., will be in the Chateau Laurier. All members attending the convention are requested to register in the secretary's office in this hotel as soon as possible after arrival in order that lists of those in attendance may be printed promptly for distribution.

The Eastern Canadian Passenger Association, the New England Passenger Association (with the exception of the Bangor and Aroostook Railroad and the Eastern Steamship Corporation) and the Trunk Line Association (with the exception of the New York, Ontario and Western) have authorized a reduced rate of one fare and three-fifths, on the certificate plan, for the round trip between any point in their territories and Ottawa. This concession is conditional upon the presentation of at least 100 certificates.

To obtain this rate a first-class through ticket to Ottawa, Canada (either limited or unlimited), must be purchased, and a certificate obtained from the ticket agent that such purchase has been made. If a through ticket cannot be purchased, then a local ticket should be obtained to the nearest point where a through ticket can be obtained for the remaining distance to the place of meeting.

Tickets for the return trip over that part of the route covered by such certificates will be sold, at three-fifths the highest limited fare, to those persons, and those only, who hold the certificates signed by the ticket agent at the point where through tickets to the place of meeting were purchased, and countersigned also by the secretary of the society, certifying that the holders have been in attendance at the convention.

Tickets on this plan cannot be purchased more than three days (exclusive of Sunday) before the time of meeting, and return tickets must be purchased within three days (exclusive of Sunday) after the date of adjournment.

Particular attention is called to the request made by the Passenger Associations that persons desiring to avail themselves of the reduced rates be at the offices for certificates and tickets at least thirty minutes before the departure of trains. Also that these rates are applicable only to through tickets to Ottawa, Canada.

Programme.

Tuesday, June 17th.—At 3 p.m. there will be a reception by the Premier, the Right Honorable R. L. Borden, and the mayor of Ottawa, at the Chateau Laurier.

Evening.—At 9 p.m. the president and officers of the society will hold an informal reception at the Chateau Laurier. Dancing may be expected.

Wednesday, June 18th.—At 10 a.m. the first session will be called to order, and the president will deliver the annual address, after which the business meeting will convene. The time and place for holding the annual convention of 1914, and several proposed amendments to the constitution will be considered, and other business transacted.

Afternoon.—Members and guests are invited to a garden party at the residence of T. C. Keefer, C.M.G., past-president, Am. Soc. C.E.

Evening.—There will be an illustrated lecture on Canadian engineering subjects in the ballroom of the Chateau Laurier. It is expected that the subjects covered will be: Transportation Routes in Canada, the Transcontinental Railway, Canadian Water Powers, Navigation, and Grain Elevators on the Great Lakes.

Thursday, June 19th.—The local committee will announce the programme for this morning at the business meeting.

Afternoon.—There will be a motor drive through the city, visiting the Parliament Buildings, Rockcliffe Park, Rideau Hall grounds, the Experimental Farm, the Chaudière, etc., and ending at 4.50 p.m. at the residence of one of the oldest members of the society, Sir Sandford Fleming, for afternoon tea.

Evening.—The Canadian Society of Civil Engineers will tender a reception to the members and guests of the American Society of Civil Engineers at the Chateau Laurier, with dancing.

Friday, June 20th.—The arrangements for Friday will be announced at the business meeting.

For those interested it should also be stated that the Royal Golf Club, which is within easy reach of the hotels by trolley, will be open to the use of our members during the convention.

S. P. Brown, M. Am. Soc. C.E., has invited all members who pass through Montreal to visit and inspect the new Mount Royal Tunnel of the Canadian Northern Railroad in that city.

TERMINAL PASSENGER STATIONS: THEIR DESIGN AND OPERATION.

By J. L. Busfield, B.Sc., A.C.G.I.

The definition of a terminal as given by the American Railway Engineering and Maintenance of Way Association, now the American Railway Engineering Association, is "an assemblage of facilities provided by a railway at a terminal or at intermediate points on its line for the purpose of assembling, breaking up and relaying trains," and also the definition of a passenger terminal is given as "the arrangement of terminal facilities for the handling of passenger business." These definitions clearly bringing out the fact that a passenger terminal is not only a station where all trains complete their run by stopping at a number of dead-end tracks, but refers equally well to a station where there are a number of through tracks, and where possibly some of the trains pass right through the terminal without any other delay than what is necessary for taking on and setting off passengers and baggage. From this it will be seen that passenger terminals in general can be divided into two classes, viz., terminals of the dead-end type, and those of the through track type.

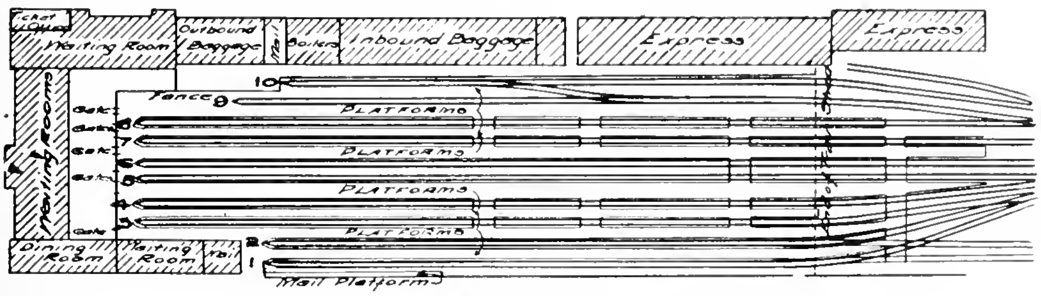


Fig. 1.—Dearborn Station, Chicago.

In a large city or town it rarely happens that a railway company is given very much choice in the selection of a site for a station, because it is tied down by the location of the railway and other controlling features. But wherever it is possible a terminal should be located as close to the hotel and residential district as possible, unless a very large suburban business is anticipated, when it is advisable to have the terminal closer to the business district. These features are well illustrated in the city of Montreal. The Grand Trunk Railway has its Bonaventure station situated about two minutes closer to the business district than the Canadian Pacific Windsor Street station, with the result that it gets about 75 per cent. or more of the suburban traffic to the Lake Shore where there is competition between the two railways, and on the other hand the C.P.R. station is more conveniently situated with regard to hotels, the residential and shopping districts, and again the Canadian Northern has selected a site right in the heart of the hotel and shopping district, and which is also within easy reach of the business section of the city.

Other factors which have also to be taken into account in the selection of a suitable location are the land available, its general size and shape; it should also be convenient and easy of access, and the question of the relative cost of buying the land and the cost of building have to be given consideration.

There are practically no railways with such unlimited resources that expense is no consideration, so, in selecting site, designs, etc., for a passenger terminal, the different possible projects have to be balanced against each other, and usually some desirable features have to be discarded, and the railway company, taking into consideration its resources available, determines which features are most essential to the welfare of the public and the improvement of the service as a whole.

The primary object of a railway's existence is transportation, consequently the railway's first attention must be given to the necessities of transportation, viz., the railway tracks, cars and motive power. In addition to these, of course, there are many accessories which are almost as important, and among these accessories are the numerous station buildings from the small one-man wayside station to the big city terminal which go to make up a big railway system.

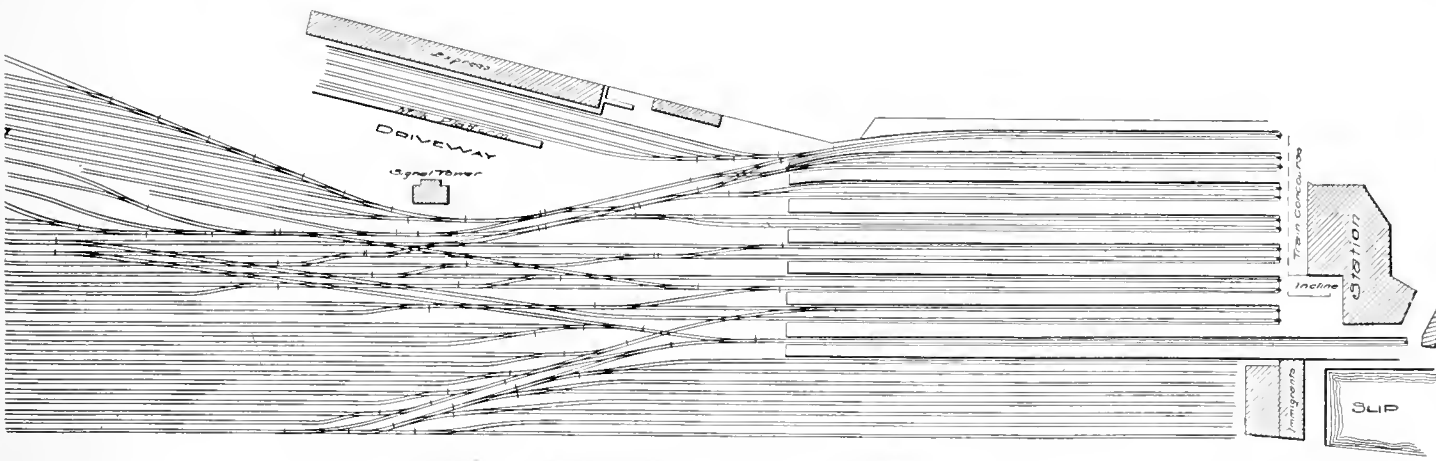


Fig. 2.—Delaware, Lackawanna and Western Railroad, Hoboken, N.J.

When the architects take over the design of a station building, they have to give consideration to the general character of the neighborhood and community in which the station is to be built. The general public usually require and demand that the station building should not only be up to the general standard of public and private buildings in the community, but that they should also set a higher mark for future developments of the community. To what extent the railway company will be controlled by the wishes of the

community will depend largely on the resources of the railway and also on local conditions of competition, but it will be usually found that the interests of the railway and the public desires are very closely allied.

Limitations are imposed upon the architect, such as the size and shape of the land available, but everything should be subordinated by him to the convenience and comfort of the travelling public, and to the economic and efficient handling of the railway company's business.

Care should be taken that architectural effect should be subordinate to utility. The building should, of course, be made handsome and agreeable without undue expense, but sometimes stations have been designed with very beautiful and artistic effect, and with little regard for the convenience of the people who use it, and on the other hand some very plain and ugly buildings are the very best from the viewpoint of comfort and expeditious handling of passengers and the accompanying facilities. The ideal is obtained when a station is designed to give the maximum comfort to the public, and which also has a pleasing exterior and interior appearance.

The necessary size of a terminal is a very difficult question for the railway and architects to deal with. The controlling feature is not only the number of passengers likely

Central station, New York, where the suburban tracks are kept below the main line. The fact that passengers will take the line of least resistance must also be kept well in mind. In a station with a large amount of through traffic there are always a great number of strangers who should be provided for in the way of indicators and sign-boards denoting waiting rooms, ticket, parcel and inquiry office, baggage rooms, etc. Lighting is also a very important feature, and the architect or engineer who designs a terminal with a maximum of daylight and with the best lighting at night without undue expense is to be praised.

Another detail which is sometimes lost sight of is cleanliness. With steam traction, locomotive dust and smoke are unavoidable, and in the interior, the building will be used by all sorts and conditions of men, women and children, so both in the selection of building materials and in also the interior decoration, this should be considered and the station designed with a minimum of carvings, mouldings, ledges, etc., and some form of interior decoration used which can readily be cleansed. This feature of cleanliness is one that should be absolutely insisted upon.

The exterior of a station building should, of course, be designed to be distinctive, and not to look like a hotel or factory, and this can best be obtained by a symmetry of lines

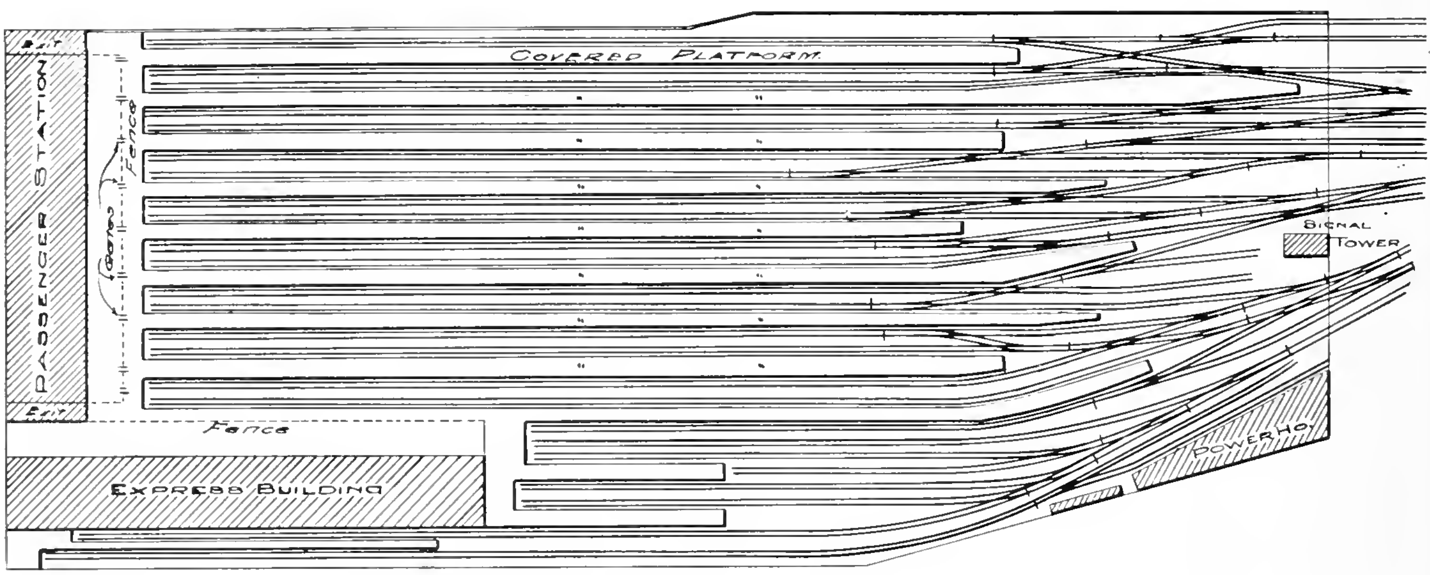


Fig. 3.—Long Island Railway Terminal, Long Island City.

to be using the station but also the rate at which they are going to use it, and the general nature of travel from the station. Again, the railway company has to take into consideration the growth of its business and design its terminal to take care of the business expected in 10 or 20 years' time.

The character of the traffic through the station makes a big difference in its general design. The station which is to provide for a large percentage of through main line travel must be provided with large waiting rooms, lunch counters, baggage facilities, etc., whereas a station with a large preponderance of suburban traffic should be designed to give easy and rapid access for large numbers of people between the platforms and streets. The suburban passenger has no occasion to stay any length of time and frequently only allows himself the minimum of time to catch his train. In a large terminal where there is a large quantity of both through and suburban traffic it is sometimes desirable to separate the two kinds entirely, avoiding considerable confusion and congestion. This is effectively done at the Grand

and masses rather than by decorative features. A good idea is to have a clock in a prominent position, on account of the close connection in the traveller's mind of time and trains.

In a great many cases the design and general size and shape of the terminal station building is dependent on the layout of the tracks and platforms at the station. These in turn are dependent on the method of operating the yard, so that in order to design the track layout the engineer must be thoroughly conversant with this method. This, again, is dependent on the nature of the traffic, number of trains handled and the rapidity with which they have to be handled, and also on the proportions of through and terminal traffic, and sundry other features which will be discussed in connection with some of the terminals of which a short description will be given.

With regard to the track layouts, terminal stations can be divided into three classes, namely, dead-end stations, through track stations and, thirdly, stations with both through and stub tracks.

In terminals of the dead-end class, the station building is usually located at the end of the tracks which is known as the headhouse type, or else it is located partly at the end and partly to one side of the tracks. The Dearborn (Polk Street) station at Chicago is a typical example of a terminal of the headhouse type. A plan of this station is shown in Fig. 1, and, as will be seen, there are two tracks which accommodate the business of the owners. The Chicago & Western Indiana Railroad and also its tenants, the Grand Trunk, Erie, Chicago-Indianapolis, Louisville, Wabash and Santa Fe Railways. The station is operated by the Chicago & Western Indiana Railroad.

Tracks 1 and 2 in Fig. 1 are mostly used for mail, but occasionally at rush times they are used for passenger trains. Tracks 3 to 8 are used generally for suburban and main line trains. Nos. 9 and 10 are used for express and baggage. The platforms average about 670 feet in length, and are 6 inches above the tops of the rails. After the passengers have disembarked from a train, the Pullmans and day coaches are hauled by a switching engine to the car storage and cleaning yards, about 5½ miles away, where they are cleaned and turned preparatory to their return journey. The baggage and express coaches are placed on tracks 9 and 10, and the mail coaches on track No. 1. On account of the number of companies using the station and the comparatively small number of tracks, no particular platforms are assigned for the arrival of trains, but they are simply put into whichever one may be empty at the time.

Another terminal of the same type, but considerably larger, is that of the Delaware, Lackawanna & Western Railway at Hoboken, N.J., illustrated in Fig. 2. At this terminal there are 127 originating and 118 terminating trains daily. These trains are handled on 14 tracks placed at 13 feet centres. There are eight platforms 20 feet wide and one 17 feet wide, 700 feet long and placed 9½ inches above the tops of the rails. After the incoming trains have been unloaded the main line locomotive, or sometimes a switch engine, takes the trains to the storage and cleaning yards. The outbound trains are made up in the coach yard and pushed towards the train shed, into which they are dropped by gravity. Each train is operated from a certain track in accordance with a regular schedule in the possession of all the station employees. Local express is handled from the express building by trucks to the various trains. The through express is all loaded into cars placed alongside the express building.

The Long Island Railroad has a terminal of the headhouse type at Long Island City. There are 135 outbound and 134 inbound trains handled at this terminal every day. There are 17 tracks in the train shed and seven others for baggage and express, as shown in Fig. 3. There are nine passenger platforms 14 feet wide and 760 feet long, placed 9 inches above the rails.

When an inbound train has been unloaded it is backed out by the main line locomotive to the car storage yard about ¼ mile away. It is here cleaned and switched and made up ready for its return journey. The express and baggage are handled on the south side of the station when in carload lots. The baggage cars are switched from the car storage yard as soon as the train is backed out of the train shed, and are taken by a switching engine to an express platform.

A station of the headhouse stub track type is that of the London, Brighton & South Coast Railway at Victoria, London, England. This station has a very novel arrangement of tracks which was designed by Mr. C. L. Morgan, chief engineer, to suit the peculiar local conditions. Some years ago the capacity of the station became too small to handle the amount of business the company was obtaining, so the question of remodelling and enlarging the station was brought up. In looking into this problem the railway company found themselves hemmed into a comparatively narrow site between Buckingham Palace Road on one side and the South Eastern and Chatham Railway on the other. A certain amount of widening was possible, but not enough for satisfactory results, consequently the station shown in Fig 4 was designed to meet the requirements. The novel feature of this arrangement is that the platforms are made long enough to accommodate two standard trains, and the tracks are so arranged that trains can arrive at or leave the inner end of the platforms without interfering with trains at the outer end. This is effected by placing groups of three tracks between the platforms at the outer ends, which are reduced with convenient switches and crossovers to two tracks at the inner ends. The old station originally accommodated six trains, whereas the new layout provides platform and track space for 18 trains.

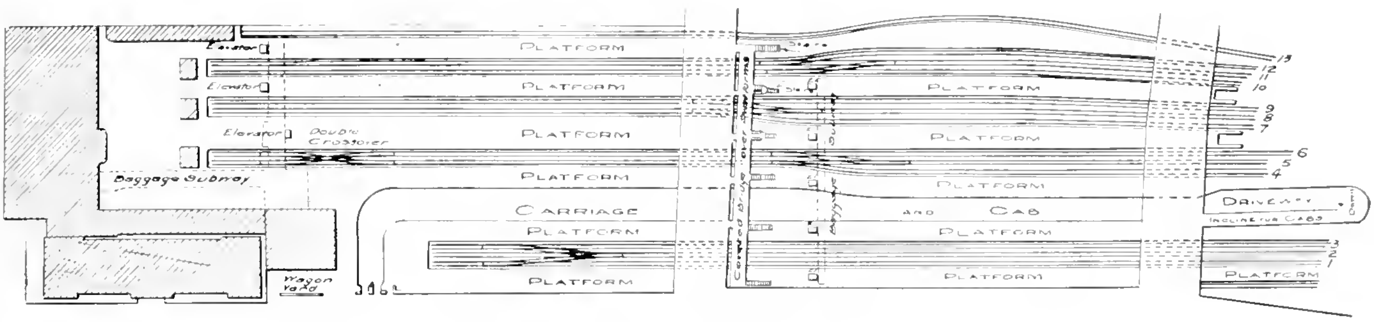


Fig. 4.—London, Brighton and South Coast Railway, Victoria Station.

The method of handling suburban trains during the rush hours is of interest. Supposing track No. 6 in the accompanying plan to be clear and an incoming train is allowed to enter right up to the inner portion. A following train can then run in behind it and stop at the outer portion of the platform. While this train is pulling in and unloading its passengers the engine of the first train can run around it and couple on the rear end, which now becomes the front end, and it is all ready to commence its trip via track No. 5 without interfering with the second train at all. An alternative arrangement is for an engine to wait on the middle track until the first train has pulled in, and then take the crossover and connect on to its rear end. After the first train has pulled out the second one can pull in to the end of the platform to take outgoing passengers, and its engine can run around it as before, or else the engine of the foregoing train will couple on to its rear end.

(To be continued.)

AN INTERESTING FILTER INSTALLATION.

Probably no one phase of municipal engineering has attracted so much attention during the past few years, at least in Canada, than that which has to do with the securing and maintenance of a proper and adequate water supply.

In Canada, where new municipalities are coming into being so quickly, and existing communities are growing so rapidly, it is quite natural to find such a great interest in this subject.

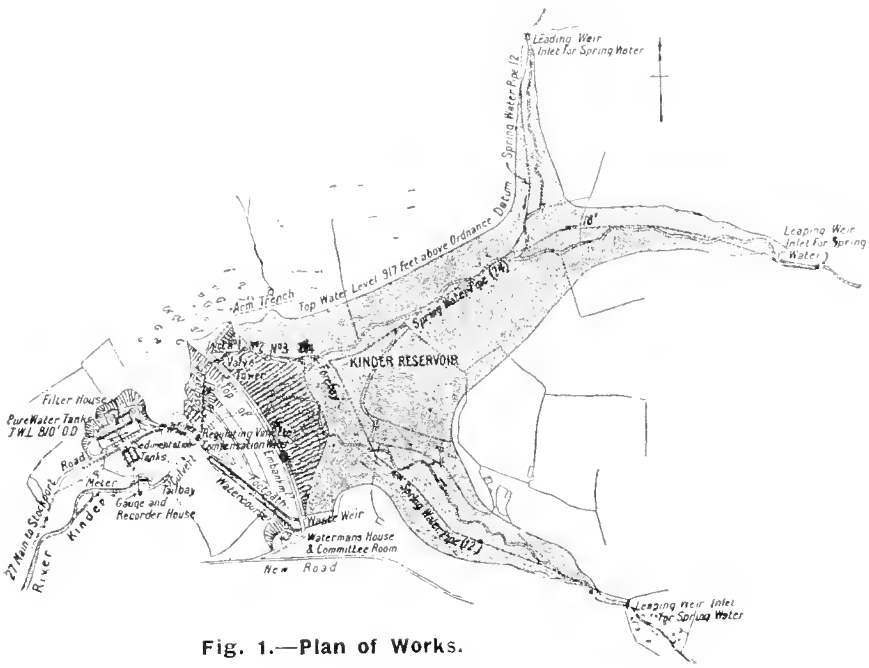


Fig. 1.—Plan of Works.

In order to place before the municipal engineers of Canada information concerning various types of filters used in Canada itself, the United States and Great Britain, *The Canadian Engineer* has, during the past few years, published descriptions of various filter installations. By studying the characteristic features of these various plants municipal engineers have been enabled to form some idea as to their relative values and thus be able to judge intelligently when brought face to face with the question themselves.

This particular article deals with an English installation, that at Stockport, which plant has a number of features which we feel sure our readers would like to be informed about.

The filtration plant proper is located at Kinder, near Stockport, named after the river upon which the reservoir is built. The engineers for the work were Messrs. G. H. Hill and Company, of Manchester. The reservoir in connection with this plant has a capacity of 515 million gallons, an area of 44 acres situated in the valley of the River Kinder. A plan of the layout will be found in Fig. 1.

The filter house, shown in Fig. 2, is built of common brick faced with stone work and is 180 feet long by 39 feet 6 inches wide, with an annex 30 feet 6 inches long by 35 feet 6 inches wide. Light for the filter house is secured by means of sky-lights in the roof. The installation called for twenty-four No. 5 Bell patent filters (provision having been made for an additional eight) and these batteries are so arranged that they can be operated as a whole or entirely separate. Fig. 3 shows a general view of the interior of the filter house and will give the reader a clear idea as to the arrangement as well as the interior construction of the house, methods of lighting, etc.

The filters consist of steel shells having hydraulically dished and flanged ends in which are placed pebble strainers which will allow the filtered water to pass through every passage, absolutely preventing the escape of filtering material. The filtering medium rests on the top of the strainer. Fixed in each shell and passing through the centre of the bed, is a hydraulic central shaft to which is connected a number of horizontal wash arms which in turn are provided with special valves and rakes. This hydraulic shaft is only used when the filter beds are to be cleaned. The two rows of four filters forming the batteries have specially constructed turbines, fitted on the end of the inlet pipe which revolve according to the flow of water passing through the filters, working in turn pumps which take their supply of standard alumina solution from small tanks and force the same into the water supply on its way for filtration. After the alumina has been applied the water is agitated and thoroughly mixed while passing through the turbines. Each of these batteries is supplied with a Venturi meter, which accurately registers the amount of water filtered and the amount of wash water.

It will be seen from Fig. 3 that the overhead travelling crane of suitable capacity is provided for, and in order to facilitate manipulation, the marine type of platform is arranged along the top of the filters.

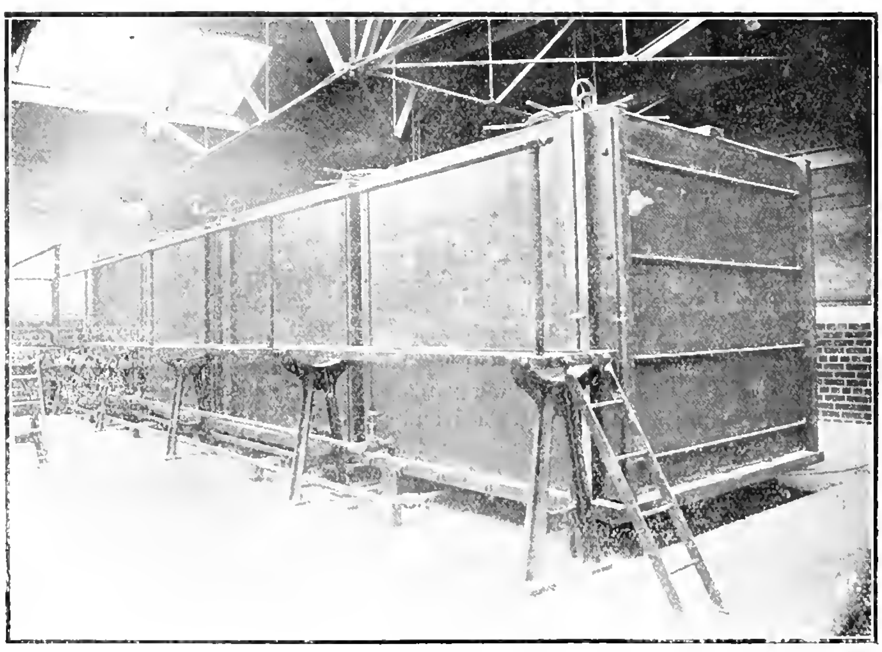


Fig. 4.—Alumina Tanks.

Each of these filters has a diameter of 8 feet and has a capacity of 3,000,750 gallons per day of twenty four hours.

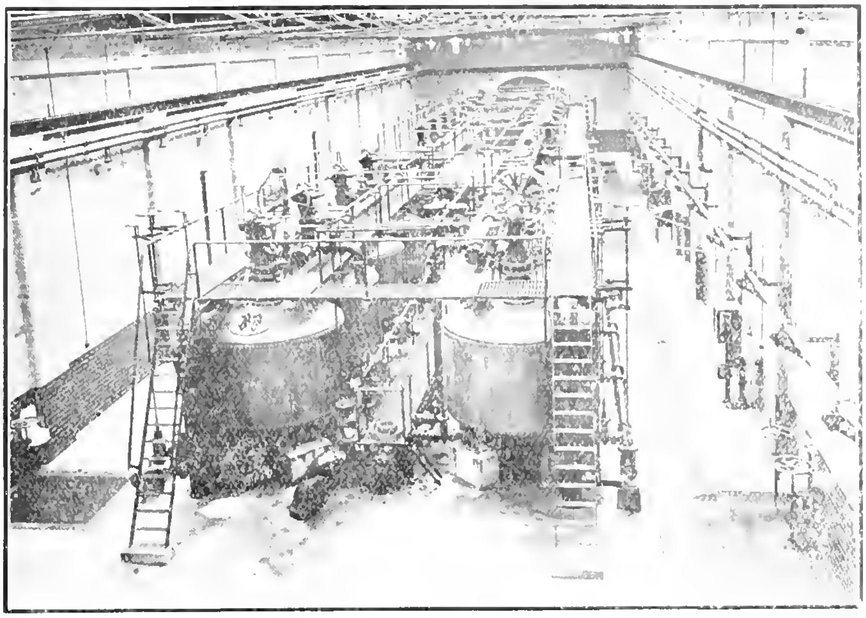


Fig. 3.—General View of Filter House Interior.

After passing through the filter, the water goes into two covered tanks in the adjoining house and with a capacity of 250,000 gallons each, which are purposely reserved for that purpose. These tanks serve to equalize the delivery of filter water to the trunk main and thus avoid direct draughts being made upon the filters themselves.

In the annex referred to are placed the lime and alumina tanks, as well as the machinery for actuating the washing mechanism of the filters and the electric lighting plant. The alumina solution tanks are shown in Fig. 4, and the gauge will be noticed at the nearest end of the tank just next to the ladder. These tanks have their own flow indicator and gauge and are so arranged that they maintain a constant supply to a distributing tank with a ball valve in the filter house.

Cleansing of the filters is done once every 24 hours and takes for the 24 filters about thirty minutes. This cleansing is accomplished by reversing the current of clean water through the filters, at the same time passing a current of

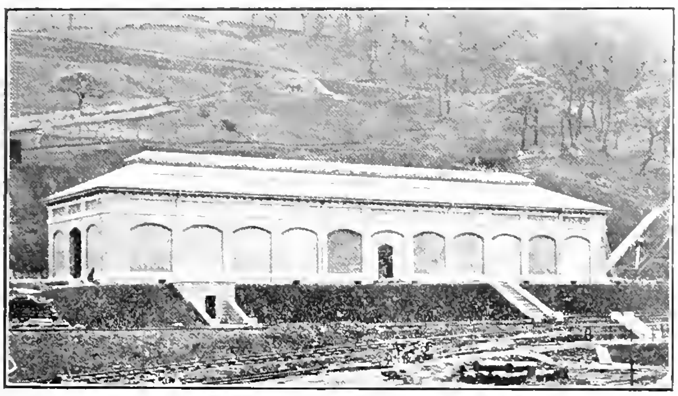


Fig. 2.—Showing Filter House.

clean water into the hollow shafts and wash arms, and also revolving the wash arms through the bed by means of a gearing supplied for that purpose. In this way the whole of the impurities which have accumulated in the filters are quickly separated from the filtering material and carried out through the washout valves and bell mouth to the sedimentation tanks. The quantity of wash water used is about three-quarters of one per cent. of the total amount filtered. After this is done the impurities in the wash water quickly precipitate in these tanks and the clear water is then discharged into the river. When cleansing is done it is only the filtered water from the other filters that is used for the purpose.

The process of washing out and stirring is continued until the water issuing from the washout tap is quite clear and free from dirt.

As showing the efficiency of the Stockport plant attached, we print herewith a report and test made by Sheridan Delepine, M.B., C.M.M.Sc., assistant director of the Public Health Laboratory, University of Manchester, under date of December 21, 1912. This report speaks for itself.

UNIVERSITY OF MANCHESTER.

December 21, 1912.
Public Health Laboratory,
York Place,
Manchester.

Sheridan Delepine, M.B., C.M.M.Sc.,
Assistant Director.
E. J. Sidebotham, M.A., M.B.,
Bacteriological and Pathological Section.
E. J. Sidebotham, M.A., M.B.,
J. E. Carver, M.D., D.P.H.,
S. M. Ross, M.D., D.P.H.,
Chemical Section.
H. Heap, M.Sc.

Received on 13th December, 1912.

Nature of sample...Water Where collected. Kinder Reservoir
Name of sender. Bell Bros. Address ....Ravensthorpe

UNFILTERED.

GGG

Quantitative Analysis	Average results of examination	
A, Acrobic micro organisms growing in 3 days in nutrient gelatine at 20° C. to 21° C.	No. of colonies in one gramme 15'43 grs. water	No. of kind Bacteria Recognizable
Non-liquefying bacteria	28	2
Liquefying	51 Total	8
	Total 139	
Other micro-organisms		
B. Anaerobic Micro-organisms		

FILTERED. Results of 3 examinations

AS ABOVE TOTAL 0

Analysis by **E. J. Sidebotham**

Remarks upon the meaning of the results of the analysis

The results are so perfect that comment is unnecessary.

Signed **SHERIDAN DELEPINE**

The Bell Filtration Company of Canada, Toronto, the Canadian company building the filters of the type herein described, have just completed the installation of a plant at Haileybury, Ont.

MODERN BLUE-PRINTING.

By P. M. Morgan.*

The Pease "Peerless" continuous blue-printing equipment prints, washes and dries the paper automatically, delivering the prints at the end of the dryer in a loose roll, free from wrinkles or distortions, and ready for immediate use.

So noiseless is this apparatus in operation, owing to the method used for electrically controlling the speeds, that there is no objection to placing it in the drafting room. The entire apparatus occupies a floor space of only 5½ x 6½ feet.

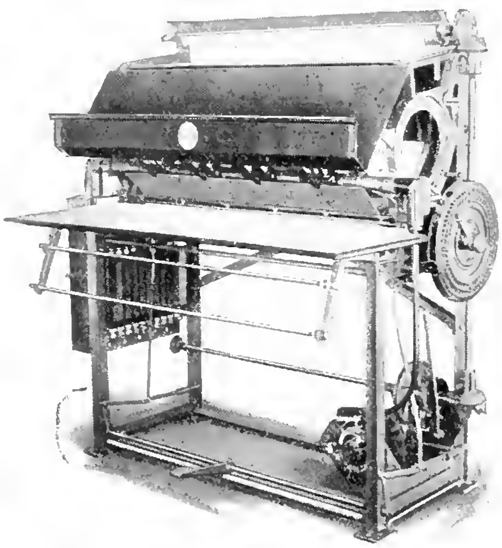


Fig. 1.

and there is no dirt or other objectionable features. It is easily possible for one operator to print, wash and dry 100 yards of blue-print paper per hour, the apparatus consuming during that time only 7 kw. of electric energy, 60 gallons of water, and 50 cubic feet of gas. Where a smaller outfit is desired it is equally practical to operate the machine for ten or fifteen minutes at a time and effect a considerable saving in the time and labor usually required in washing and drying. The printing machine can be used independently at any time if desired for an occasional print.

It can readily be seen that by placing this apparatus in the corner of the drafting room, the operator's time, when he is not engaged in operating the machine, can be used to excellent advantage for other work about the drafting room. These machines were designed for general practicability for all classes of electric printing, and with especial reference to low operating and maintenance expense. They are built in various sizes, to suit the largest or smallest engineering department.

Fig. 1 shows the machine ready for operation. The paper may be printed in sheets or in rolls as desired. Two spindles are provided underneath the feeding table for carrying different widths of paper. The tracings and paper are carried upward past a bank of arc lamps by means of an endless canvas belt. The tracings are returned direct to the operator's hand as he stands in front of the machine; which is a most important feature, as much saving of time is effected in this way. The exposed paper may be returned in the same way or pass over the top roll of the machine. The exposed paper may immediately be seen and the correct exposure obtained before any prints are spoiled, merely by moving the finger on the dial of the rheostat which is placed on the end of the machine convenient to the operator's right hand.

No transparent bands or expensive glass cylinders are used, but in place thereof a short segment of heavy plate glass, which is so mounted and adjusted that breakage is practically impossible. Tension springs at either end of the machine automatically take up the stretch of the canvas belt, so that the most perfect contact between tracing and paper is obtained at all times, while a special device prevents side travel of the belt. Fig. 2 shows the machine with the heavy enameled iron tracing tray pushed back and one lamp turned down on the table, illustrating the method employed for trimming the carbons and cleaning the globes. These arc lamps were especially designed for this machine. It will be noted that they are connected in at the bottom, and each lamp is provided with an aluminum reflector. The resistance coils are carried away from the lamps underneath the table, thereby producing a uniform light and largely reducing the heat. All wiring is encased in steel tubing, and each lamp and motor is independently connected, the switches being enclosed in a metal box at the left-hand end of the machine. By means of the individual connection it is necessary to use only a sufficient number of lamps to cover the width of the tracing being printed. No friction discs or belts are used for controlling speeds, all speeds being electrically controlled directly through the motor. Any possible speed can be obtained, from four inches per minute, which allows sufficient exposure for the slowest negatives or black line prints, up to six feet per minute, which our experience has demonstrated is as fast as the average run of tracings can be properly fed to secure the greatest efficiency from electric energy consumed. A fan is provided for circulating the air, as shown on the left-hand end of the machine.

Fig. 3 shows the blue-printer connected with the Pease automatic washing and drying machine. The paper passes over the top roll of the printing machine into the washer,

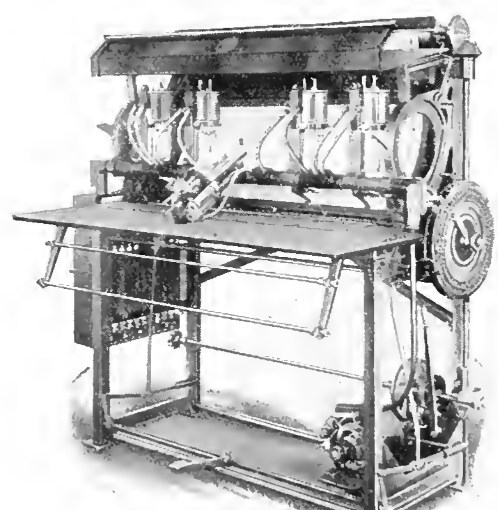


Fig. 2.

where it is first washed by a spray of clear water; then by a weak solution of bichromate of potash which is pumped over and over from the tank shown in the rear of the machine; and lastly by a spray of clear water, after which the paper passes up over the dryer and down into the winding-up device. The printing machine may be used independently

* Vice-president, The C. F. Pease Co., Chicago, Ill.

when desired by simply pulling out a clutch on the washing and drying machine.

When the apparatus is not in use it is customary to keep it threaded up with a strip of blank paper, one end extending onto the end of the feeding table of the printer, and the other end into the re-winding device. After the run is finished the leader is placed on one of the spindles under the feeding table, the sensitized paper is cut off a few inches beyond the

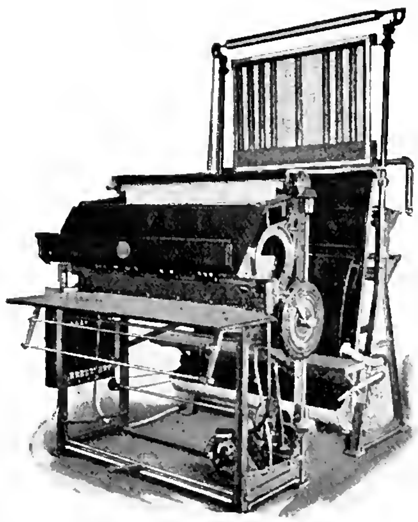
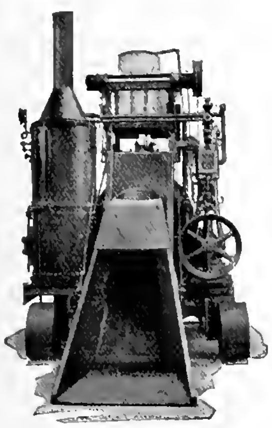


Fig. 3.

end of the last tracing, and the end is pasted onto the end of the leader, the machine being allowed to run until all of the prints have passed into the winding-up device and the leader is again in the machine ready for starting.

NEW STREET PAVER.

The Chain Belt Company, Milwaukee, Wis., announce that they are now manufacturing a paver. The machine is provided with a reversible traction drive so that it can be moved forward or backward by its own power. The traction drive is fitted with a friction clutch. It is connected to both rear wheels and is sufficiently powerful to propel the machine up an incline of 15 degrees.



Charging Side of Street Paver.

No platforms or runways are required and if the material is placed sufficiently close to the machine it can be shovelled directly from the supply pile to the open end power loader bucket. The paver is equipped with a boom 20 feet long and delivery bucket. The concrete is discharged from the mixer into the delivery bucket, which travels on a single boom. The boom can be swung at an angle of 180 degrees, and a street 50 feet wide can be taken care of. The boom bucket will hold a full batch of the mixed concrete and is provided with an automatic tripper. The gates open up automatically at any place where it is desired to deposit the concrete. When the bucket returns to the mixer, the gate closes automatically. In work where the road is less than 18 feet in width a gravity swivel chute may be substituted for the distributing boom.

ILLUMINATING ENGINEERING SOCIETY.

At a meeting of the Convention Committee of the Illuminating Engineering Society, held in Pittsburgh, Friday, May 16th, it was decided to hold the next annual convention in that city during the week beginning September 22nd.

The Convention Committee consists of Mr. C. A. Littlefield, New York Edison Company, chairman; Mr. P. S. Miller, Electrical Testing Laboratories, president of the Society; Mr. H. S. Evans, Macbeth Evans Glass Company, Pittsburgh, Pa.; Mr. W. A. Donkin, contract manager Duquesne Light Company, Pittsburgh, Pa.; Mr. D. McFarlan Moore, General Electric Company, Harrison, N.J.; Mr. M. C. Rypinski, Westinghouse Electric and Manufacturing Company, New York; Mr. C. J. Mundo, General Electric Company, Pittsburgh, Pa.; Mr. J. C. McQuiston, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.; Mr. W. J. Sterrill, United Gas Improvement Company, Philadelphia, Pa.; Mr. S. B. Stewart, Philadelphia Company, Pittsburgh, Pa.; Mr. T. J. Pace, Westinghouse Electric and Manufacturing Company, Pittsburgh, and Prof. H. S. Hower, Carnegie Technical Schools, chairman of the Local Section of the Society.

Mr. W. A. Donkin, of the Duquesne Light Company, was selected as chairman of the Local Committee on Arrangements, which will have charge of the Convention. Mr. J. C. McQuiston, of the Westinghouse Electric and Manufacturing Company, was appointed chairman of the Publicity Committee, and will make all arrangements for advertising the Convention.

It is expected that several hundred engineers from all parts of the country interested in lighting in its various forms will be present, and the progrmme, details of which have not as yet been completed, will consist, in addition to the technical sessions, of a reception and dance, several excursion trips and visits to various industries in Pittsburgh.

CHICAGO RAILROADS ON ELECTRIFICATION.

Eight of the steam roads which enter Chicago made a joint statement to the committee on railway terminals of the city council, on May 12th, and requested that action be deferred until another year on a proposed ordinance, which, while it does not specifically require electrification, under the police authority of the city orders an abatement of all the nuisances occasioned by the operation of locomotives. The statement points out that the railroad situation in Chicago "is entirely different from that in any other part of the United States where electrification of terminals has been attempted."

In order to keep pace with the development of their business, the Canadian Fairbanks-Morse Company, Limited, have had designed by Messrs. Pringle & Sons, Limited, of Montreal, a new building which will be situated at the corner of St. Antoine and St. Cecile Streets, that city. This building will be modern in every sense of the word and will be specifically laid out to adequately take care of the various departments of the business. It will have seven floors and a basement, and will be built of reinforced concrete with brick facing. An interesting feature of the building is that which makes it possible for a five-ton truck to run into the basement. The elevator equipment will consist of two freight and one passenger elevators. This building, when complete, will house the entire business, including the storage and demonstration rooms, as well as the repair shop, and will prove a very decided addition to Montreal's business buildings.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS:

BOOK REVIEWS.

The Gas, Petrol and Oil Engine. Volume 2. By Dugald Clerk, D.Sc., F.R.S., M.Inst.C.E., and G. A. Burls, M.Inst.C.E. Longmans, Green & Company, 39 Paternoster Row, London, Eng. 8 Vo., VII., 838 pages; 478 figures. Price, $7.50.

The name of Dugald Clerk is too intimately associated with the literature of the gas engine to require any comment, and Volume 2 of the Gas, Petrol and Oil Engine, produced in co-operation with Mr. G. A. Burls, M. Inst. C.E., is a fitting sequence to what he has previously produced. This book as a whole, will form a welcome addition to the library of anyone concerned with the development of internal combustion engines, while chapter three, dealing with igniting arrangements; seven, petrol engines; eight, some petrol engines described, and nine, on carburettors, will prove specially instructive to those interested in automobiles or motor boats.

As the authors state, Volume 1, "On the Thermodynamics of the Gas, Petrol and Oil Engine, Together with Historical Sketch" was published in 1909. The sequel to this, Volume 2, deals with practical problems of design, construction, and operation of these engines. Commencing with chapter one, the reader is shown the development of the four-stroke engine, and given the results of tests made on various types, while in chapter two a similar method is adopted with regard to two cycle engines.

Igniting arrangements are discussed under the following groups: (1) Flame method. (2) Incandescent method. (3) Methods depending on Catalytic, or chemical action. (4) Electrical methods.

Section two of this chapter treats on ignition in small, high-speed petrol motors suitable for motor cars and boats, and section three of sparking plugs.

Speed regulation, governors and governing methods are fully described.

Chapters five and six, on the various fuels used in internal engines, are more than ordinarily valuable. The various fuels are described and compared and the whole matter covered in a concise and thorough manner.

The remainder of the book deals with petrol engines, carburettors, heavy oil engines, marine gas and oil engines with an appendix on the acceleration of the reciprocating parts. The book as a whole forms a distinct addition to the literature of internal combustive engines, their fuels and accessories. The entire subject is thoroughly covered, the matter lucidly arranged, and the many tables and illustrations add much to an interesting and useful work.

The Practical Railway Spiral. With short working formulas and full tables of deflection angles, together with examples by L. C. Jordan, B.S., C.E., Principal of the Civil Engineering Department, Heffley Institute, Brooklyn, New York. Publishers, D. VanNostrand Company, New York. Illustrated; 155 pp.; 4 ins. x 6½ ins. Price, $1.50 net.

The author adopts as the rule for the close approach to the ideal in curves: Divide the spiral length into six equal parts; lay out 5 per cent. of the desired degree of curvature in the first part; in each of the next four equal parts of the spiral length attain 20 per cent. of the desired degree; and in the remaining portion of the length accomplish the remaining 15 per cent. This rule is given because of the objection to the ordinary spiral on the grounds that the grade of each rail due to run-off is curved at the ends where it joins the track grade, and that due to the play in gauge the outer wheel flange in leaving the tangent for the curve strikes a blow against the rail as it is brought against it for curvature. Whether the rail will improve the riding qualities of the track can only be determined by trial.

The tables in the book are all for the six-cord spiral for lengths of 150, 225, 300 and 450 feet. A spiral length of 150 feet for ordinary curves and 300 feet for high-speed is advocated regardless of the degree of curvature, but the method of using other chord lengths and degrees of curvature is explained on the basis of constant angles and deflections for a constant ratio of length to radius and varying angles or deflections in the ratio of length to radius when the ratio is not constant.

The author brings out in the book the present inconsistencies in the use of spiral curves on American railways, and recommends a carefully worked-out and practical spiral, as described above. It is designed on the principle of limiting the rate of tipping or run-off of elevation at the end of the circular curve to two inches per second of time, elevating the outer rail for centrifugal force to a maximum of 6 inches, and limiting the speed for the sharper curves to correspond with the length.

Apparently the author would like to standardize in practice and get away from the inconsistencies in practice of the railways, some of whom vary the length of spiral with the degree of curvature, some with the amount of super-elevation, some with the speed of the fastest trains, and some design the length of the spiral from a bending of two of the above causes.

The book, in its tendency to standardize practice in spirals is deserving of all success. We believe it will prove of interest and value to all railway engineers.

Specifications for Street Roadway Pavements. By S. Whinery. Published by the McGraw-Hill Book Company, New York. Size, 6 ins. x 9 ins.; cloth, 116 pp. Price, $1 net.

This is the second edition of this work, the original edition having been issued in 1907. The work will be found of exceedingly great interest to those who have to do with the construction and maintenance of pavements as, in addition to a large amount of information on specifications specifically, which is included in Part I. of the book, Part II., comprising 26 pages, is devoted to instructions to inspectors on street paving work and will be found of great use. Practically all types of pavements are dealt with and the specifications submitted covering these pavements will be found very valuable to city engineers and municipal authorities in general. The book contains very copious foot-notes and altogether the work is one which will be welcomed by all those interested in the question of road construction and maintenance.

Natural Rock Asphalts and Bitumens. By Arthur Danby. Publishers, Constable & Company, Limited, London, Eng. 244 pp.; 4¾ ins. x 7¼ ins.; cloth bound; illustrated. Price, $2.50 net.

The author opens with the statement that beyond the occasional articles in the technical journals and the pamphlets issued by the manufacturer, producer or seller of asphaltic materials there is no English work that is at all modern covering this subject. The book deals with the geology, history, properties and industrial applications of natural rock asphalts and bitumens, and contains a great deal of information that will appeal to any and all who have to do with the production, sale or use of these materials for any purposes whatsoever. The book goes into the geology of rock asphalts and bitumens; the sources of rock asphalt and bitumens; history and ancient uses of each of these materials; where to test and analysis, physical properties of rock asphalt. The use of rock asphalt for mastic work is given a special chapter. Altogether the work is one that is thorough, full of interest on a subject which is to many comparatively little known, and will prove exceedingly useful in making clear to many who are using these materials just what they are. The author has omitted unnecessary technicalities. Tests have been kept as simple as possible and the book should find a large sale because the subject is most ably handled. The author has clothed an otherwise dry subject with an interest that holds the reader's attention in a peculiar manner.

Transmission Line Formulae. By H. B. Dwight. Published by the D. VanNostrand Company, 25 Park Place, New York. Cloth; 137 pages; 28 figures; 17 tables. Price, $2.00.

The object of this treatise is to compile a set of instructions for engineers which will enable them to make electrical calculations for transmission lines with the least possible amount of work.

The book may be divided into two parts. The first five chapters are designed for those who have an ordinary acquaintance with alternating current calculations. The second section is for reference and contains the mathematical derivation of the formulae used in transmission line work. A transmission line regulation chart is presented for use in determining transformer regulation and efficiency.

The volume is clearly written and the formulae should prove invaluable to electrical engineers interested in transmission work.

Railroad Construction. By Charles Lee Crandall, M.C.E., and Fred Asa Barnes, M.C.E. Publishers, McGraw-Hill Book Company, New York. 321 pp.; 6 ins. x 9 ins.; cloth bound; illustrated. Price, $3.00 net.

This work, so the authors tell us in their preface, had its beginning in some notes on railroad construction which were first prepared about twenty-five years ago and issued in mimeograph form for the use of students at Cornell University.

The first chapter of the book takes up railroad construction generally and covers estimates; right-of-way; outlines of construction; clearing; shrinkage; overhaul; etc. Chapter two is devoted to earth work and contains a number of illustrations of well-known earth removing equipment, such as steam shovels, scrapers, graders, plows, dump cars, etc. Chapter three deals with the subject of rock excavating, principles of plasting, explosives, etc. Chapter four takes up the subject of tunnelling in which the various methods used in different countries are described and illustrated. Other chapters of the book cover the subjects of masonry, culvert work, foundation, track material, trestles and bridges, estimates and records. At the end of each chapter is given a table of references which will doubtless be found exceedingly useful to railroad construction engineers. There is a very full and complete cross index which forms a valuable feature of the book, as too many books are spoiled by the absence of a comprehensive and serviceable index.

Asphalt Construction for Pavements and Highways. A pocket book for engineers, contractors and inspectors. By Clifford Richardson, M.A.S.C.E., F.C.S., consulting engineer. Published by McGraw-Hill Book Company, 239 West 39th Street, New York. Size, 7 ins. x 4½ ins.; flexible binding; pp. v + 155. Price, $2.00 net.

This book, as the author states, is written with a view of supplying necessary and helpful information in regard to asphaltic concrete and asphalt broken stone pavements. It has created a demand for highway engineers, contractors, and inspectors who are schooled in this work far in excess of the supply, and the result has been that many of them do not realize the importance of careful attention to details which is necessary to insure complete success in this line of work. The author states that the pocket book has been prepared with the hope of insuring better work in the future than has been done in some cases in the past. Its form has been selected so it can be readily carried in the coat pocket for reference on all occasions.

The book is made up of seventeen chapters and an index which should be a great help in rapidly locating desired points of information. Chapters I. II. and III. are very brief, making in all a total of eight pages, and are titled: Introductory, Broken Stone, Foundation. Chapter IV. deals with "The Intermediate Course." Chapters V., VI. and VII. are on Mineral Aggregate-Filler and Dust-Native Bitumens. Chapters VIII. and IX. are on Fluxes and Cement. Chapter X. is the longest in the book, containing about fifty pages, and is on Surface Mixtures. Chapters XI., XII. and XIII. deal with Maintenance and Repair, The Plant, Work Upon the Street. Chapter XIV. is advice to engineers, contractors and inspectors, and is made up of suggestions to the above three and to citizens. Chapter XV. is upon Preparatory Work; Chapter XVI., Methods for Examination of Bituminous Materials and Mineral Aggregates; Chapter XVII. contains instructions for taking samples and specimens for examination; Chapter XVIII., reference Tables.

The book should prove very handy to contractors and inspectors and to engineers not fully posted upon asphalt pave-

ments and highways. It places simply and concisely before the reader the principles and reasons for the best highway practice and should prove very serviceable in the field for which it was intended.

Rainfall Reservoirs and Water Supply. By Sir Alexander R. Binnie, M. Inst. M.E., F.G.S., F.R.M.S., M.R.I. Publishers, Constable & Company, Limited, London, England. Size, 5¼ x 8½ ins.; cloth; 157 pp.; illustrated. Price, $2.50.

This book is founded upon the Chadwick Trust Lectures delivered by the author at the Institution of Civil Engineers in February, 1912. The object of this treatise is not so much that it might be regarded as a treatise on waterworks engineering, but more particularly to illustrate some of the salient points connected with what the author regards as one of the most difficult branches of engineering. The book deals with the questions of water and water supply in their broadest aspects, and goes into the question of the sources of supply; gravitation versus pumping; drainage areas; rivers and pumping works; aqueducts; conduits; intensity of floods; evaporation, etc. The chapter on filtration contains a number of illustrations of mechanical filters, including the Bell, the Mather and Platt, and Ransome filters. The book is fully illustrated and will doubtless prove of great interest to all students of the subject. A feature of the book which deserves a special commendation is the full cross index. It enables one to find in the minimum of time just what he wants. The book contains 56 plates and tables, and the data gathered together are drawn from various parts of the world, but particularly from Great Britain. The book will have a very special interest for Canadian engineers, in that its author was recently in Canada, having been called in company with Dr. Houston by the city of Ottawa to report on the water problem as applied to that city.

Reinforced Concrete Bridges. By Mr. Frederick Rings, M.C.I., M.S.A., C.E. (Ger. Inst.) Architect and Consulting Engineer. Published by Messrs. Constable & Company, London, England. Size, 7¾ ins. x 11 ins.; 186 pp. Price, $6.25 net.

The book is devoted specifically to the use of reinforced concrete with special reference to bridge work, and includes what to the author seems the most important features and facts the designer of bridges should be acquainted with. The bridges illustrated comprise a large variety of types common to the bridge engineer. The book discusses the advantages and disadvantages of reinforced concrete for bridge work. The question of waterproofing materials to be used, etc., is taken up in the introductory chapter. The succeeding chapters are devoted to Bending Moments, Stresses and Strains; Loads on Bridges and External Stresses; Culverts, Coverings, Tunnels, etc.; Beam Bridges; Calculation of Girder Bridges and Work Examples; Design of Arched Bridges and Abutments; Examples of Arched Bridges; etc. The work is most profusely illustrated by very excellent photos and line engravings, and will doubtless be welcomed by bridge engineers interested in reinforced concrete design and construction as a valuable addition to the literature on the subject. It contains a number of folding diagrams and from pages 158 to 181 there are a series of tables which will be found exceedingly useful to bridge engineers generally.

Rules and Regulations for Inside Electrical Installations. This is a book of rules issued by the Hydro-Electric Power Commission of Ontario and contains 129 pages. It discusses the subjects of 'installation work, wiring electric plants, grounding, maintenance and operation, and also instructions on resuscitation from electric shock. The book is illustrated and will be found of special interest to everyone who is connected with the installation or operation of electric plants of any kind whatever.

PUBLICATIONS RECEIVED.

Canadian Peat Society.—Illustrated journal issued by Canadian Peat Society, Castle Building, Ottawa, Ont.

United States Department of Agriculture.—Monthly list of publications as received by the department, Washington, D.C.

Ore Dressing and Metallurgical Laboratory.—Bulletin 160. Issued by the Mines Branch, Department of Mines, Ottawa.

Revenues and Expenses of Steam Roads for January, 1913.—Bulletin No. 50. Issued by Interstate Commerce Commission.

Annual Report of the Philadelphia Bourse.—Twenty-second annual report as presented by the directors' meeting of May 13, 1913.

Canadian Forestry Journal.—Sixty-four page journal dealing with forest conservation. Issued by the Canadian Forestry Association, Ottawa.

American Society of Mechanical Engineers.—Illustrated journal published by the society, May, 1913. Address, 29 West 39th Street, New York.

Specification of Peebles' Standard Turbo Alternators.—Specifications of alternators. Issued by Bruce, Peebles & Company, Limited, Edinburgh.

Mine Inspector of the Territory of Alaska.—Report of mine inspector for the fiscal year. Issued by the Department of the Interior, Washington, D.C.

Forest Service Investigations.—Illustrated review of the work conducted by the Forest Service; issued by Henry S. Graves, United States Department of Agriculture.

Patents.—Illustrated official journal of patents of Great Britain, April 9, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C. Price, 6d.

Forest Conditions.—Illustrated bulletin issued by T. W. Dwight, M.F., Department of the Interior, Canada, on forest conditions in the Rocky Mountains forest reserve.

Selection of Explosives.—Illustrated bulletin on the selection of explosives used in engineering and mining operations. Issued by the Department of the Interior, Bureau of Mines, Washington, D.C.

American Railway and Bridge Building Association.—Proceedings of the 22nd Annual Convention, held at Baltimore, October, 1912. 9 ins. x 6 ins.; 295 pp.; numerous illustrations. Price, $1. Apply C. A. Lichty, secretary, 26 West Jackson Boulevard, Chicago, Ill.

Good Roads.—Hearings before the Joint Committee in the Construction of Post Roads, January 21st, 1913. Part I.; 9 ins. x 6 ins.; 220 pp. Apply A. W. Prescott, secretary, Joint Committee on Federal Aid in the Construction of Post Roads, Washington, D.C.

Tests of Reinforced Concrete Buildings Under Load.—An interesting, illustrated bulletin on the tests of three large buildings, by A. W. Talbot and W. A. Slates. Copies may be obtained from the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Report on the Tractions Improvement and Development of the Toronto Metropolitan District.—A most exhaustive report taking in all phases of transportation as it affects Toronto and outlying districts. The text of the report covers present traffic conditions; car lines recommended; cars and service requirements; costs and returns. Contains twenty-six photographs and drawings. Forty-eight 6 x 9 ins. pages.

Reconnaissance Along the National Transcontinental Railway in Southern Quebec.—Interesting booklet written by John A. Dresser and published by the Department of Mines. Deals with the general geology, description of land formations and topographical character of the Laurentian and Appalachian highlands and the St. Lawrence lowlands.

The Concrete House and Its Construction.—A practical working volume containing important details involved in the construction of concrete dwellings. Nicely illustrated, showing interior and exterior views of noted concrete houses. Issued by the Association of American Portland Cement Manufacturers, Land Title Building, Philadelphia, Pa.

Producer-Gas Power Plant in the United States.—By R. H. Fernaed. Is a nicely illustrated bulletin dealing with the present status of the producer-gas power plant, fuel-testing, blast-furnace and coke-oven gas plants. Also the views of manufacturers, owners and operators of producer-gas plants, and has attached map showing graphic distribution of producer-gas plants in the United States. Issued by the Department of the Interior, Bureau of Mines, Washington, D.C.

The Reading Iron Company, of Reading, Penn., send us Bulletin No. 10, which is devoted to an illustrated description of the Illmer gas engine, which engine possesses a number of new features. The engine is intended primarily for driving electric generators, pumps, rolling mills and other heavy duty service operating at a reasonable load factor. To those interested in the subject we would strongly advise them to send for a copy of this bulletin and we are sure it would be gladly sent by the manufacturers.

Bulletin of Revenues and Expenses of Steam Roads in the United States.—This is a pamphlet prepared by the division of statistics and covers the revenues and expenses of railways during the month of February, said railways reporting to the Interstate Commerce Commission. In the bulletin will be found operating revenues and expenses of large railways and their principal subsidiaries showing whose total operating expenses exceed one million dollars. The pamphlet contains 36 pages, 9 ins. x 12 ins.

Torquay Water Undertaking.—This is an illustrated description of the new filtration plant at Torquay. Issued by the Candy Filter Company, Limited, of London, by which firm the installation was carried out. The plant has a capacity of two and a half million gallons per day and the sketch of the work done is written by Samuel C. Chapman, water engineer of the municipality of Torquay. The pamphlet contains twelve pages, one half-tone illustration and two diagrams, one showing the layout of the filters and the other a cross section.

Good Roads.—Tables showing in condensed form for ready reference and comparison, data regarding the highway systems of the leading nations of the world and statistics bearing upon federal aid in highway improvement in the United States. Compiled by the Hon. J. Bourne, Jr., chairman of the joint committee on federal aid in the construction of roads for the United States Congress. Revised print, March 20th, 1913. 12 ins. x 9 ins.; seven folded charts. Apply A. W. Prescott, secretary, Joint Committee on Federal Aid in the Construction of Post Roads, Washington, D.C.

Expert Evidence.—Verbatim report of a discussion held at a meeting of the American Institute of Consulting Engineers, Eugene W. Stern, secretary.

A most exhaustive discussion on the subject referred to above is contained in the fifty-eight pages of the pamphlet and will well repay any engineer who may have the privilege of reading the same. In as much as there is a good deal of opposition to the present methods of securing expert evidence in legal cases, it is an exceedingly interesting subject, and one that is of great importance to the engineering profession. The following well-known engineers took part in the discussion: Mr. Rudolph Hering, Mr. Gustav Lindenthal, Mr. Cary T. Hutchinson, Mr. L. B. Stillwell, Mr. Sanford Thompson, Mr. Frank H. Waterman, Mr. Livingston Gifford, Mr. Alfred Noble, and Mr. E. W. Harrison.

The discussion was full of information that should be brought to the attention of every engineer who is likely to be called upon to give expert evidence where cases are before the courts, and where engineering knowledge is needed. It makes good reading.

CATALOGUES RECEIVED.

All Famous.—Illustrated pamphlet, 10 pages. Issued by the Heine Safety Boiler Company, St. Louis, Mo.

The Universal Crane and Excavator.—Illustrated catalogue; 15 pages. Issued by the C. O. Bartlett & Snow Co., Cleveland, Ohio.

American Vanadium Facts.—Illustrated catalogue published by the American Vanadium Company, 341 Vanadium Building, Pittsburgh, Pa.

The Hardy Simplex Hammer Drills.—Illustrated catalogue showing three types of drills. Issued by Mussens, Limited, 318 St. James Street, Montreal.

Blacksmithing and Drop Forging.—Illustrated bulletin dealing particularly with heavy forgings. Issued gratis by the Tate-Jones & Company, Inc., Pittsburg, Pa.

Bayer Railway Speed Recorder.—Illustrated catalogue, giving description and instruction for applying and operating recorder. Issued by the Chicago Pneumatic Tool Co., Fisher Building, Chicago.

The United States Graphite Company's Products.—Illustrated catalogue issued by the United States Graphite Company, Saginaw, Mich. Deals with the company's graphite products and is intended to serve the trade as a convenient reference.

The B. Greening Wire Company, Limited, of Hamilton, send us a copy of their catalogue which contains a very full and complete illustrated description of their various specialties. It also contains an historical sketch of the business which was started 'way back in 1858. The catalogue contains 228 pages, is fully indexed, and contains among many other things a number of interesting tables which will be of interest to all those who use wire goods of any description.

Text Book on Corrosion.—An interesting bulletin published by the Stark Rolling Mill Company, of Canton, Ohio, sole producers of Toncan metal. Contains interesting technical information on the introduction of mild steel, rust and corrosion, chemical electrolysis, conservation of metals, efficiency, elimination of corrosion, and value of galvanizing steel. Is nicely illustrated, showing prominent installations of Toncan metal, and is a complete compendium of all necessary information in reference to sheet metal.

The Great Market Street Paving Contract is the title of on interesting booklet issued by the United States Wood Preserving Company. Copies will be sent to interested persons on request by the Canada Creosoting Company, Canadian Pacific Building, 1 King Street East, Toronto. The booklet tells how the Market Street Merchants' Association of Philadelphia, Pa., decided to use wood block when they investigated the problem of repaving Market Street after the street had been torn up for the construction of a subway. The report of the committee and a report by a firm of paving chemists, newspaper clippings, illustrations of streets, etc., are included.

COAST TO COAST.

Toronto, Ont.—Chief Engineer F. A. Gaby, of the Ontario Hydro-Electric Commission, reached this city after a five months' flying tour of the continent. His mission, which was to gather electrical data towards the more efficient operation of a power and lighting system, he claims was very profitable. Much technical information dealing with power production was gathered and this will be embodied in a report for submission to the commission. "Ontario leads in transmission lines," was the comment he made on the problem of distribution. He told of a scheme closely resembling that of the province which had been formed in Sweden and was now on a running basis. The same ideas of carrying power to homes and farms were used, but whereas in some ways their operation was an improvement, he declared that the transmission line system here outclassed any he had seen. He stated that little public ownership on a large scale was apparent, but that several thriving cities, especially in Germany, managed their own systems. France, Germany, Switzerland, Holland, Sweden and England were visited and their leading electrical plants inspected.

Toronto, Ont.—The good roads programme of York county was brought before the Ontario cabinet recently and is at the present time obtaining consideration. After the usual system by which the government advances one-third of the amount raised by the city and county, the $300,000 voted two years ago has been expended. Now, in view of the plans of the government as to a broader policy for old Ontario, it is a question how far roadways should proceed under the old standard. York county, which was represented by Lionel H. Clark and Engineer James, has voted for additional expenditure, and seeink ratification from the minister of public works, the best method to pursue under the circumstances is being debated in cabinet. It is understood that if the present plan goes through, the sum of $100,000 will be asked of the government.

Montreal, Que.—That the $2,000,000 floating drydock placed here last fall is likely to prove to be a white elephant is confessed by shipping authorities. It was thought that shipowners would use the dock for all repairs needed by vessels, but it has been found that no company will put a ship in the dock while there is the slightest chance of sending it to British ports for repairs. A case in point is that of the Elder-Dempster steamer "Benguelo," which will get a much-required scraping when she gets to South Africa, where the work can be done by cheap black labor. As the shipping companies are getting cheaper insurance by reason of the dock being here, it is suggested that while they will not use it, they are not entitled to the advantage and that it should be taken to Quebec.

Victoria, B.C.—Arrangements are in view for a thorough investigation of the water supply of Victoria as derived from Elk Lake, the examination to be made of water from points both at the entrance and exit of the filter beds at Beaver Lake. Until recently only chemical analyses were possible. While these tests are sufficient to detect any organic impurities, it has been impossible, until the city possessed a laboratory where bacteriological experiments were possible, to know what amount of bacteria was passing through the sand, and in fact, to what extent the filter beds were discharging their office. When these tests have been made it will be possible to determine whether the sand is effective, and what percentage bacteria is detained in the beds in process of filtration. A series of systematic tests is proposed by the city analyst on behalf of the water commissioner.

Vancouver, B.C.—Vancouver has lost more than $450,000 in business this year through not having a commercial drydock, but two groups of engineers and financial men are arranging to supply the need, according to statements made recently at the meeting of the Board of Trade in connection with report given upon the recent visit to Ottawa of Mayor Baxter and Mr. W. A. Blair, secretary to the board. Mr. Blair gave statistics regarding boat repair work which went to Esquimalt and Seattle the first three months of the year, but which, in his opinion, would have come to Vancouver had there been a drydock here. Six passenger boats which call at Vancouver had gone to Esquimalt for repairs totalling $226,000, and $75,000 had been expended there upon smaller craft. Seattle has obtained $150,000 through work on other boats which call here. Mr. Blair prefaced his report by the statement that the delegation did not go to Ottawa to form a company to build a dock, but to strengthen the hand of Mr. H. H. Stevens, M.P., in presenting the claims of the city for the establishment of a drydock and a grain elevator. After citing his figures with reference to the loss of business to Vancouver, he said the delegation was informed no naval dock would be built for several years, and the delegation then devoted attention to the question of the commercial dock. As a result they obtained assurance that the drydock subsidy would be changed to favor the financing of such an enterprise. Change of the Act will not be made until next session, but if a bona fide company makes a proper showing the interest will be increased by an order-in-council to 4 per cent. on $6,000,000 for thirty-five years on progressive estimates, and the action ratified by legislation. Mr. Blair said he had good reason to believe that a drydock would be built soon, and that it would be a credit to the promoters and to the city. Mayor Baxter said that since his return representatives of two groups considering the building of a dock had been in conference with him.

Ottawa, Ont.—The Board of Railway Commissioners, being impressed with the large number of accidents occurring at level railway crossings (crossings of one railway by another) which are not protected by signal system with or without derails approved by the board, are asking that railway companies subject to the jurisdiction of the board, show cause, in writing, within thirty days, why an order should not issue requiring such railway companies to install and complete, within three years from date of such order, an interlocking system to be approved of by the board for the protection of all level crossings which are not so protected between tracks of steam railways and between tracks of steam and electric railways.

Peterborough, Ont.—City Engineer Parsons has returned from Toronto, where he went to look into the sewage disposal question respecting Peterborough. Mr. Parsons waited upon Dr. McCullough, chief of the provincial board of health for Ontario, and ascertained the latter's views regarding a suitable plant for this city. The provincial board of health favor the use of Imhoff tanks either with the treatment of the effluent by chlorination, or by sprinkling or intermittent filters. The scheme will have to be worked out with a view of determining the probable cost, not only the first cost, but also the question of maintenance. Mr. Parsons also visited the Toronto engineering department, but was unable to obtain anything that would be applicable to Peterborough. The next move will be to prepare plans and submit them to the provincial board of health engineers for their approval.

Vancouver, B.C.—Preliminary work for the construction of the Georgia-Harris viaduct is rapidly progressing to a point where citizens can readily observe tangible indications of a prompt completion of the project. The contractor already is receiving on the ground the lumber for constructing the form work for the superstructure at the Harris Street

end. The steel shoes for the six concrete caissons to be sunk in False Creek are expected to arrive soon, and plans have been devised for sinking the large cylinder down to hard pan. All of the thirty-six footings in Harris Street, from Main Street to False Creek are in place. Some of the footings have been sunk to a depth of fifteen feet and the steel for the remainder of the footings has been delivered on the job. The excavation has begun for the retaining wall at the foot of Georgia Street, and for the various piers through the Canadian Pacific Railroad property. The sinking of the cylindrical caissons, 12 feet in diameter and 40 feet long, will be started as soon as the steel shoes now in transit arrive. The concrete cylinders will be eight inches thick. The steel ties and tracks will be laid in the concrete as it is poured for the various sections. The viaduct, of concrete construction of the Turner mushroom system, will be 2,880 feet long, sixty-six feet wide, and will carry a 53-foot roadway having double tracks in the centre. Various electrical conduits will cross the structure which will be erected along the outer edge, which will be provided with six-foot walks. Massive concrete railings will be erected along the outer edges, which will be provided with 54 ornamental lamp standards of fluted columns made of concrete.

Victoria, B.C.—"Battleships versus Good Roads" would be a good topic for debate among certain enthusiasts for improved highways in the United States, according to George E. Daniels, the well-known authority on automobiles, who has some very decided views on the comparative advantages of well-constructed highways over huge navies, and it is his opinion that greater benefit to the country at large can be obtained through a good roads movement than through a plan to increase the equipment of the navy. "I am perfectly sincere," says Mr. Daniels, "in declaring my preference for the good roads propaganda over the agitation for more vessels of war. I believe that the American Congress, instead of increasing the naval appropriation for the sake of building up a large navy, should spend these millions on national turnpikes. It seems to me there is sound reason for this preference. There is no greater factor in the creation of progress and prosperity affecting our people at large than good roads. It would be silly to assert that good roads are merely to increase the pleasure of a favored few. There is nothing that has a greater economic significance than roads well maintained, for they open up the country so that its fullest commercial development is possible. Moreover, they are the arteries of civilization and without them whole districts stagnate. In this connection they have a distinct ethical value. In general they promote the peace, prosperity and happiness of a country and should therefore receive consideration long before we consider increasing our naval prestige. It is rather humiliating to think that the old countries of Europe, so far behind us in many ways, have learned this and appreciate good roads. When it comes to highways, we are sadly behind Europe, as anyone who has travelled abroad and also through our own states knows full well. It seems curious that we who are such a practical people and presumably so keen for progress and material success should so flagrantly neglect this great factor. Therefore, I say, the time is at hand to boost the good roads movement."

Winnipeg, Man.—Providing the engineering problem is feasible and the cost not too great, Shoal Lake will be the source of supply of the Greater Winnipeg water district. A large majority of the members of the city council attended a meeting of the fire, water and light committee held recently, and after hearing a very satisfactory report on Shoal Lake water from the three consulting engineers, it was unanimously decided that the consulting experts should not be asked to go to Winnipeg River, but that if it is found advisable, they may later be asked to make a supplementary report on the Winnipeg River from data contained in existing reports. The question of filtration of Shoal Lake water was raised by all three of the experts who explained that while it was by no means necessary it might be regarded by the citizens as advisable. They made it plain that Shoal Lake water is pure and soft, and from the hygienic standpoint absolutely clean, but they explained that suspended vegetable matter might cause a slight taste or smell. Engineer Fuertes declared that Shoal Lake water is better than New York has used for 20 years. The members of council lost no time in deciding that there would be no filtration in the meantime and that Shoal lake water is quite good enough as it is. The formal motion, put forward by Controller Midwinter, read: "That the board of consulting engineers be instructed to report on the best means of supplying the Greater Winnipeg water district with Shoal Lake water, with estimate of cost and general plan of work." At the same time it was agreed that should the report not prove as favorable as is anticipated, the engineers should later make a supplementary statement on the feasibility and cost of a supply from the Winnipeg River. Mr. J. H. Fuertes, New York; Frederick P. Stearns, of Boston, and Mr. Hering, are the consulting engineers.

PERSONAL.

R. HUNTER, assistant engineer of the Beach pumping station, at Hamilton, Ont., has resigned to take up a position at Welland, Ont.

DR. JAMES DOUGLAS, of New York, graduate of Queen's, has sent Dean Goodwin a cheque for $25,000 for the establishment of tutorship in the School of Mining.

W. H. RANDALL, superintendent of the waterworks maintenance and distribution of Toronto, will attend the annual meeting of the American Waterworks Association, which meets in Minneapolis, Minnesota, from June 23 to 26.

MR. H. A. DONOVAN, who has been connected with the electrical department of the Winnipeg Electric Railway Company, of Winnipeg, Canada, has been appointed assistant electrical engineer of the company, succeeding Mr. E. A. Graham, resigned.

MR. D. R. KENNEDY, electrical superintendent of the British Columbia Electric Railway Company, of Vancouver, B.C., has resigned his position, and Mr. W. H. Fraser, who has been connected with the electrical staff of the company, has been appointed in his place. Mr. Kennedy will spend the next few months travelling through the States and the Dominion, inspecting various electrical plants.

MR. D. McD. CAMPBELL, city engineer of Sydney, N.S., has resigned. Mr. Campbell entered the service of the city as a member of the city engineer's department in 1900, and was appointed to the position of city engineer in 1908. It is understood that Mr. Campbell is to engage in private practice as a consulting engineer. The board of works of the city of Sydney accepted his resignation with a good deal of regret and so expressed themselves.

ARCHIBALD CURRIE, C.E., graduate of Glasgow University, and member of the Institute of Civil Engineers of London, Eng., at present city engineer of Westmount, Que., has been appointed city engineer of Ottawa. Mr. Currie has had a wide experience, holding positions in Scotland, England, China (during the Boxer trouble), and South Africa. He has been city engineer of Westmount since 1911, and has given general satisfaction since his appointment. He will commence his duties at Ottawa on June 20.

CAPTAIN A. W. GRAY, assistant highways commissioner of Ontario, has been appointed highways commissioner

for the parks branch of the Department of Interior, Ottawa. The position is a newly created one and the object of the government is to establish a series of fine highways through the public parks of the west for automobiles and for horses. Captain Gray is an engineer of high standing and has had many years of experience in the work of highways construction. He is an expert in his particular line and the appointment is regarded as an excellent one. He will probably make his headquarters in Edmonton, Alta.

OBITUARY.

ARCHIBALD GUTHRIE, prominent railway contractor, died May 18th, at Chicago, following an operation. Deceased was 77 years old and was born at Lanark, Ont., and received his education there, entering the contracting business, and at the time of his death was senior member of the firm of A. Guthrie & Company. He gained distinction in early northwest railway extension, and carried to completion some of the most pretentions plans in railroad building in the country.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—

177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, P. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 23 Toronto, June 5, 1913

Contents of this issue on page 819

The Canadian Engineer

An Engineering Weekly

TERMINAL PASSENGER STATIONS; THEIR DESIGN AND OPERATION.

By J. L. BUSFIELD, B.Sc., A.C.G.I.

(Continued from last issue.)

Another interesting feature which is quite prevalent in British railway terminals is the cab and carriage driveway between the two inbound platforms. This enables passengers to step right from the train to the cabs and carriages without any delay. The platform may also be reached by means of stairways from a footbridge in the middle of the station. The baggage is handled from the baggage room to the train platforms by means of subways and elevators.

The American Railway Engineering Association have designed a typical track layout suitable for a dead-end station of medium size. This layout is illustrated in Fig. 5, and it is of interest to look into the general requirements and conditions met with in a terminal of this type.

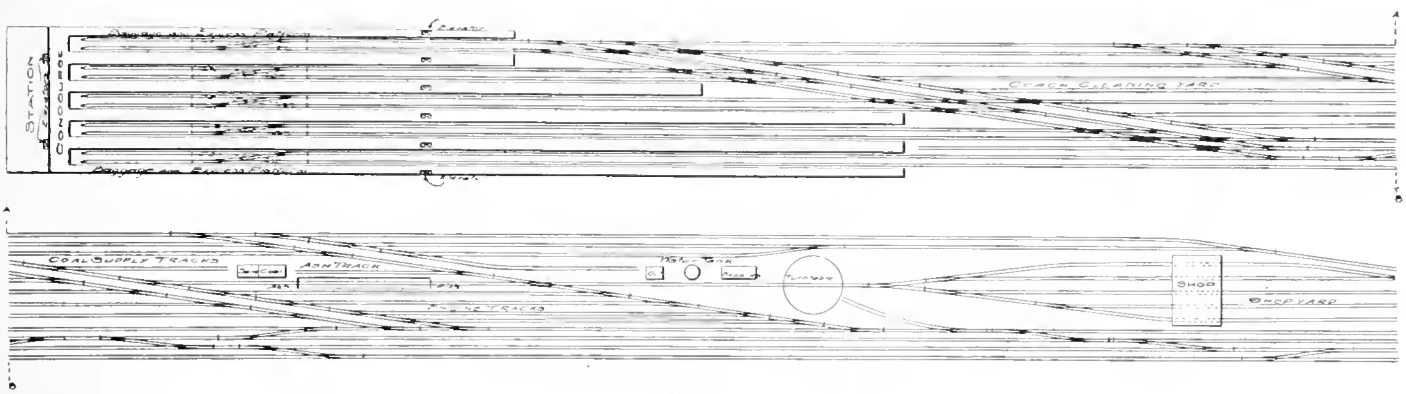


Fig. 5.—Typical Dead-End Terminal.

In order to secure the maximum efficiency of tracks and facilities and the minimum installation expense, the terminal facilities must be designed so as to provide such an arrangement of tracks and platforms that will permit the greatest freedom of movement with the least interference, so that incoming and outgoing trains may be handled without delay.

In most terminal stations facilities have to be provided for hauling the majority of the trains out of the station proper and placing them in a special cleaning yard, and frequently after they have been cleaned they have to be placed in a storage yard, previous to their being placed in the train shed ready for the outgoing journey.

It is sometimes necessary to arrange for trains at a terminal to arrive and depart in rapid succession, and it is in this case that great care must be taken in designing the track layout so that there will be the minimum of interference between the inbound and outbound movements. If the track layout is properly designed it will be possible in many cases to permit trains to enter the station at the same time as other trains are leaving and to fill vacant tracks with the least delay. This will insure maximum efficiency and a minimum of installation cost.

The number of trains that can be handled at a platform or, in other words, the track capacity, depends largely on the rapidity with which the baggage and express can be handled while the train is at the platform, so that in order to have the maximum number of trains operated on the minimum number of tracks the baggage and express handling facilities must be the best possible, and arranged to give the minimum amount of interference to the movement of passengers. This feature is best obtained by handling all the baggage and express either below or above the train floor and transferring it to the platforms by elevators. This method eliminates the annoyance and discomfort to passengers which results from trucks on long and busy platforms.

The time required to handle a train in the terminal, i.e., to load and unload passengers, baggage and express, depends largely on the nature of the train, as it takes longer to put the baggage and express on to a main line train than it takes the passengers to embark, while in the case of a local train the conditions are exactly reversed, but is has been found that the number of trains that can be conveniently handled per hour per track varies from two for main line trains up to a maximum of eight for locals, with an average of 4.1 trains per hour. These averages were obtained from a number of large terminals, but they are naturally liable to large variations, depending on the nature of the traffic.

If facilities are provided for the continuous and rapid handling of baggage and express without interfering with passengers it is believed that a terminal can be operated with such efficiency as to give an average of 6.5 trains per hour. In order to obtain this high efficiency, the track layout and all facilities must be designed with this object of saving time.

In the plan shown in Fig. 5, representing a typical dead-end station, with eight platform tracks, it will be noted that the double-track arrangement is preserved at the entrance to the train shed in such a way as to give practically continuous use of the platforms and tracks. This double-track arrangement is only made possible by the use of slip-switch cross-overs which allow a train to keep to its own right-hand track until it reaches the outer end of the platform to which it is assigned. Similarly a train can arrive at outermost platform at the same time and without interference from an outgoing train from any of the other platforms. With the old layout of a single ladder, the incoming train would have to wait at the throat of the yard until the outgoing train had passed on to its own main line track.

In connection with this typical plan of a dead-end station, the committee of the American Railway Engineering Association came to the following conclusions:

"(1) To avoid excessive cost in providing passenger terminal facilities largely in excess of ordinary requirements, it is imperative that provision be made for the economical, efficient, and practically continuous operation of the terminal during the periods of greatest activity, which may reasonably be expected within a period of, say, twenty years. To this end the track layout may be designed to permit incoming and outgoing movements to be made at the same time without interference as far as possible to arrange this."

"(2) At passenger terminals where large quantities of baggage and express must be handled, and it does not appear expedient to use intermediate platforms exclusively for this service, it is recommended that (where conditions permit) baggage and express be received, delivered and handled below the train floor and raised and lowered by elevators, conveniently located, to avoid interference with the movement of passengers."

The plan in Fig. 5 shows, in addition to the train shed trackage and platform arrangements, typical recommended arrangements for the coach yards for storage and cleaning, etc. These are only incidental to the general scheme, as in most cases the layout and location depend entirely on local conditions.

The design and layout of a terminal passenger station of the through type is a very different subject to that of a dead-end terminal. The through terminal can be more economically and efficiently built and operated than a dead-end terminal, as the number of platforms required to handle a certain volume of business is less in a through terminal, because trains can be handled in and out very much more rapidly. There are practically two types of through terminals proper, namely, those with the station building to one side of the tracks, and those with the building built over, or above the level of the tracks.

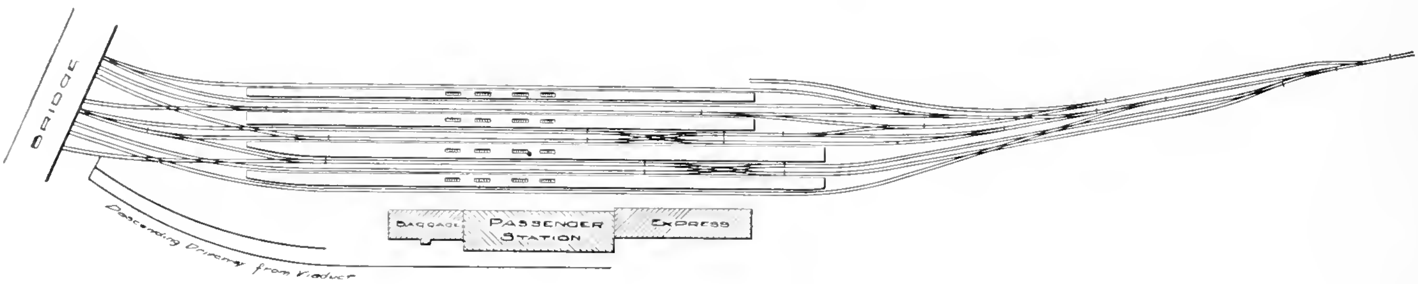


Fig. 6.—Union Station, Columbus, Ohio.

A large terminal of the through type is the Columbus Union Station owned by the Pittsburg, Cincinnati, Chicago & St. Louis Railway, and by the Cleveland, Cincinnati, Chicago & St. Louis Railway jointly. There are in all six railway companies using this terminal. The general layout is shown in Fig. 6. There are four platforms, three 17 feet wide and one 11 feet wide. Two are 678 feet long and the other two have been extended to a length of 774 feet. These platforms are all 8 inches above the top of the rails. The tracks in pairs are spaced at 11 feet centres and the edge of the platform is placed 5 feet ¾ inch from the centre of the track. The tracks are all below the street level.

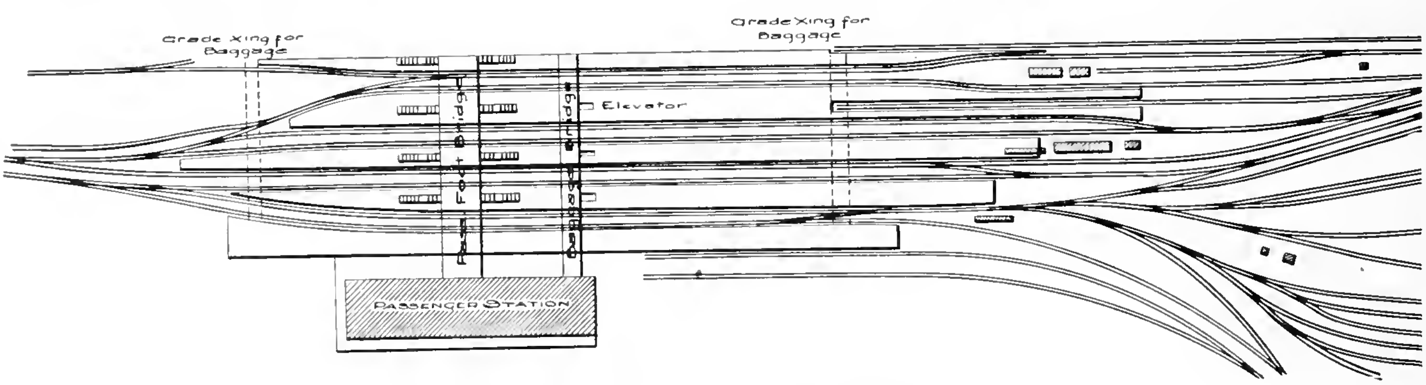


Fig. 7.—Harrisburg, Pa., Pennsylvania Railroad.

The front entrance and general waiting room are all on the street level. The passengers reach the platforms from the general waiting room by means of an overhead bridge extending across all the tracks, from which stairways lead down to the platforms. There are also stairways from the platforms down to a subway below the tracks which connects with the basement of the station. This subway is only used for rush business. The baggage and express rooms are on

the basement floor, the baggage between the waiting room floor and the basement being handled by means of elevators.

There are 51 through trains, 34 originating and 35 terminating trains handled at this station per diem. The trains terminating are broken up with yard engines and each tenant company has its own engines which take its train to its own separate sorting and storage yard.

Another large through terminal is that of the Pennsylvania Railroad at Harrisburg, Pa. (Fig. 7). At this station there are 52 through trains, 47 originating and 45 terminating per day, and practically all of these are through main line trains, as there is very little suburban business. This station is a terminal of four divisions of the Pennsylvania Railroad and of the Cumberland Valley Railroad, the latter having independent stub tracks. Engines are changed on all through trains here; cars are frequently added to or taken from the trains. The switches are all operated by means of an interlocking plant.

There are four pairs of tracks placed at 12 feet 2½ inches centres, with platforms between each pair. Two of these platforms are 22 feet wide, and the remaining ones are 15.8 feet, 33.9 feet and 37 feet in width, with lengths of 765 feet to 850 feet. The platforms are reached by means of stairways and an overhead bridge at the waiting room level.

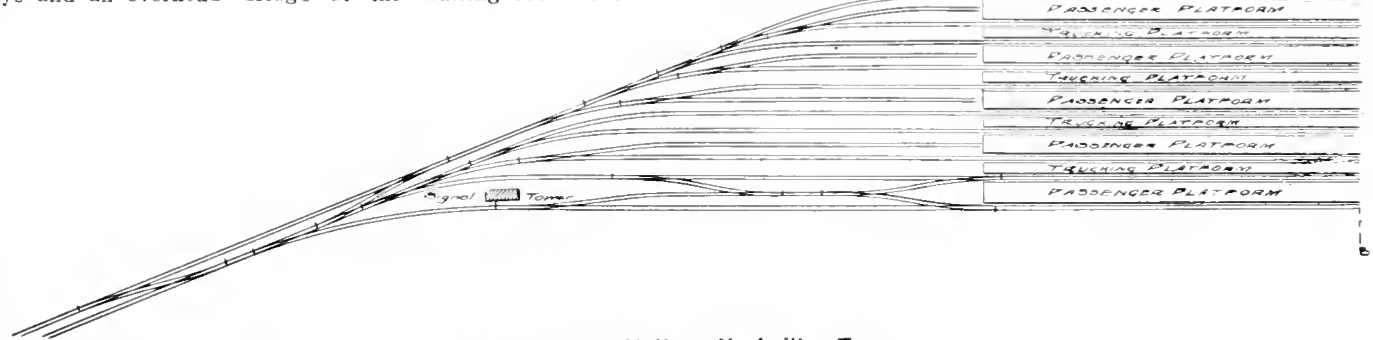
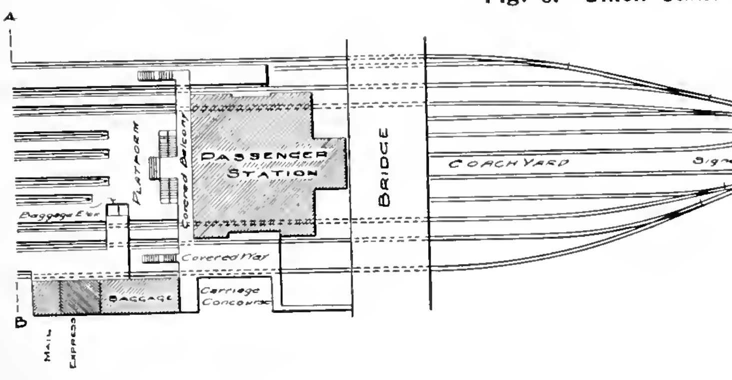
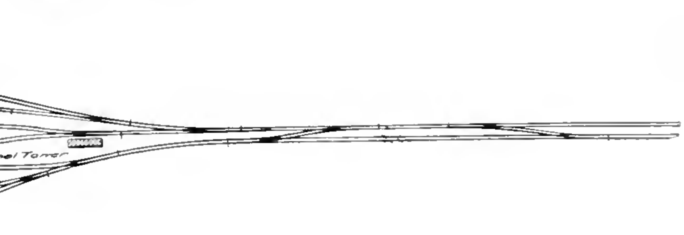


Fig. 8.—Union Station, Nashville, Tenn.





Another overhead bridge is provided for the baggage and express service, the trucks being lowered to the platforms by means of elevators.

The engine house at this terminal is about ¾ mile away from the station and the car storage yard is about 650 feet west of the station yard. The cars are handled between the engines and the storage yard by switching engine.

Another type of terminal commonly met with is the combined through and dead-end terminal, having a number of stub tracks and also a number of through tracks. A typical example of this kind is illustrated in Fig. 8, showing the layout of the Union Station at Nashville, Tenn., owned by the Louisville and Nashville Terminal Company and leased to the Louisville and Nashville Railway and the Nashville, Chattanooga & St. Louis Railway jointly.

There are 10 through and 26 originating and 26 terminating main line trains daily and no suburban trains. A certain amount of switching and making-up of the through trains is done, putting on and taking off Pullmans, etc.

There are six through tracks and four stub tracks in this terminal, spaced alternately 20 feet and 28 feet between centres, except where the train shed columns are situated on the platforms, where the spacing is 34 feet. The platforms are divided into passenger and trucking platforms, the former being 20 feet wide and the latter only 11 feet. They vary in length from 550 feet to 750 feet and are 9½ inches above the rails.

The engine house is over ½ mile away from the station and the car storage yards are over ¼ mile away. All the trains are handled and made up in the terminal and yards by switch engines.

The station building itself is placed at the end of the stub tracks and the through tracks pass to either side of the station, except one which passes through the lower part of the building.

The waiting rooms and general accommodation in the station is on the street level, above the tracks, and the passengers reach the platform from a balcony with stairways to the platforms and to a concourse at the end of the stub tracks.

These terminals described above will give a general idea of standard practices with regard to the different kind of passenger terminals, but at some of the more recent and larger terminals, such as the New York Central's Grand Central Station in New York, certain improvements have been introduced.

There are a number of problems, however, which the designer has to solve apart from difficulties due to the local conditions. For instance, he has to decide on the relative merits of handling baggage through subways and elevating to the platforms, or handling the trucks on special trucking platforms (as at the Nashville Union Station) reserved solely for this purpose, or as is more commonly done in the older terminals, to have the regular platforms wide enough to enable the baggage to be handled in the same platform as the passengers without causing inconvenience and delay either to the passengers or to the baggagemen.

The track layout at a terminal has been given much more serious consideration in recent years than formerly, with the result that the double ladder has been developed.

in order to bring the double track to each platform, so as to give great flexibility of movement and almost unlimited capacity for handling suburban traffic with electric trains.

Another phase of station design which is being brought into general use now is the elimination of stairways, and the substitution of inclined ramps between the different levels of the station, waiting rooms, platforms, subways, etc. In many cases, on account of limited space, the use of ramps becomes impossible, but where they have been put into service they have proved very satisfactory.

At the Grand Central Terminal, New York, while the alterations were being made experimental ramps at different grades were built in order to find out what grade the public preferred to take; it was found that the ramp with a grade of 8 per cent. was most popular. However, it is not always possible to use such a flat grade as this, but it should not be steeper than 10 per cent.

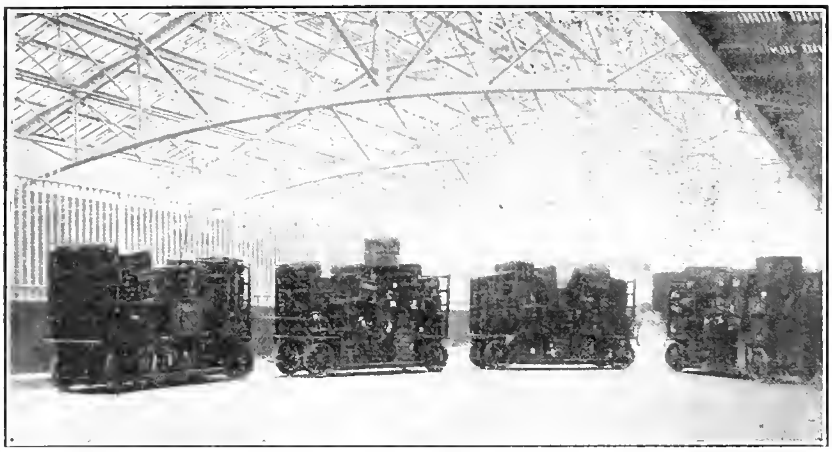


Fig. 10.—Drop Frame Electric Baggage Trucks.

A terminal where these modern ideas have been put into effect is that of the New York, New Haven & Hartford Railway, at Providence, R.I. The structure is substantial and pleasing to the eye, the driveway and approach is covered in. At the rear of the station building is the train shed with a concourse intervening. There are eight through tracks and the intermediate platforms are reached by subways and ramps. Another feature of this station worthy of special mention is the large and commodious toilet room accommodation which, unlike many stations, is provided with plenty of daylight and good ventilation.

Fig. 9.—Pennsylvania Electric Baggage Truck.

The description of passenger terminals would be incomplete without a reference to the use of storage battery electric motor trucks for handling baggage and express. The Pennsylvania Railroad was one of the first to see the possibilities of this type of truck and commenced experimenting with them as early as 1904, but it was not until 1910 that they actually commenced to use them. It was also about this time that the New York Central Line commenced installing them.

Twelve trucks were first put into service by the Pennsylvania Railroad at their Jersey City terminal in 1910. These trucks were 12 feet long and 44 inches wide, with the platform 30 inches above the ground. This truck is illustrated in Fig. 9. The frames were of all steel construction, the ends were of pressed steel. Both pairs of wheels were mounted with knuckled axles and the steering gear so connected that all four wheels were utilized for steering, thus enabling the truck to turn in a very confined space. This feature, though, was not entirely necessary because the trucks are arranged so that they can be operated from either end. The steering and controlling gears are linked up to duplicate lever sockets at either end of the truck, so placed that when not in use the sockets do not project beyond the ends of the trucks. The handles cannot be removed whilst the truck is in motion. The operators' platforms are hinged and connected so that they cannot both be down in running position at the same time, but if necessary they can both be placed vertically against the ends.

The motive power of these trucks is an Elwell Parker motor, which is flexibly suspended so as to oscillate about the counter-shaft. The requisite speed of the driving wheels is obtained by a double reduction gear through a countershaft. The pinion on the countershaft is connected to it with a universal joint to allow for the turning of the driving wheels. This pinion drives on to an annular gear rigidly fixed to the driving wheel.

The wheels are of the artillery type, 27 inches diameter, one pair of wheels has the annular gear for the drive and the other pair are fitted with internal expansion brakes.

The battery on these trucks is of 12 cells, capable of giving 196 amp. hours, and is placed on a tray suspended on compression springs. The controller gives three speeds in both directions, the two running speeds giving four to five miles per hour and five to seven units per hour respectively. The weight of the truck is 2,390 lbs. and it has a capacity of 4,000 lbs.

The Elwell Parker Company, of Chicago, Ill., are now manufacturing two types of these baggage trucks, one is the straight frame type and is practically identical with the one originally built by the Pennsylvania and illustrated in Fig. 9. The other type they are now building is the drop frame type illustrated in Fig. 10. This truck has the centre part of the platform dropped down to within a few inches of the station platform. This truck was designed for especial use in terminals where the platforms are placed at the height of the car floors.

At one large terminal exhaustive tests were made with these trucks comparing them with hand trucks. For mail handling it was found that one electric truck operated by one man would equal the performance of 2½ hand trucks and five men, based on the full capacity of the trucks, viz.,

two tons for electric and one ton for the hand truck. For baggage handling, two hand trucks were equivalent to one electric. Actual figures with the hand truck as a basis were obtained as follows:—

	Electric Truck.		Hand Truck.
	Mail.	Baggage.	Mail or Baggage.
Fixed charges, interest, insurance, taxes	15.0	18.75	1
Depreciation: trucks, batteries, tires and switchboard apparatus	18.82	23.53	1
Maintenance: labor and material	4.2	5.25	1
Operation: labor and power	.21	.26	1
Total charges	.33	.42	1
Saving of electric over hand truck	67%	58%	

In Fig. 10 one truck is shown hauling three other loaded trucks.

A very complete installation of 16 electric baggage trucks of the drop frame type has been installed at the North Station, Boston. These trucks are similar in size and general design, control, etc., to those described above, and are used practically entirely for handling express. In these trucks there is rather a novel braking feature. The operators' platform is divided into two halves, the left half operating the brake. Normally the brake is on, and to release it the operator has to press down the left half of the platform. This has the advantage of almost instant stoppage if the operator steps off his platform.

The conditions met with at this terminal are particularly severe. There are 738 trains handled daily, on 23 parallel tracks, with intermediate and side platforms from 7 to 16 feet wide. At the station end of the platforms the trucks have to ascend and descend a 12 per cent. grade, and as there are passenger gates at the lower end this requires very efficient and quick-acting brakes. So far these trucks have been successfully operated without accident. Another saving has been found to be in decreased damage. Packages frequently dropped off the hand trucks, but it has been found that breakages from this cause with the electric trucks are practically nil, owing to the electric drive, rubber tires, flexible frames, etc.

With an equipment of this size it is necessary to have a complete set of operating rules to prevent confusion. In the operation of the trucks all are carefully examined before being placed into service and each truck is numbered with figures three inches high for reference. The trucks are started step by step similarly to a street car. Operators are not allowed to converse with any one while in charge of a truck, and are cautioned to use great care at gateways and passages. When operating on the main platform at the bumper ends of the train tracks the trucks take the middle of the course except that in passing others those operating on the main platform are given the right of way over those approaching from trains. Running backward in the station proper is also prohibited, and no trailers are permitted. Trucks proceeding in the same direction must keep 15 feet apart.

The Canadian Pacific Railway have installed two of these electric baggage trucks at the Windsor Street Station, Montreal, Que., and having found them satisfactory, are ordering a number of others for different points on their system.

EFFICIENCY IN THE PUMPING STATION.

By Seabury G. Pollard.*

The following extracts taken from an article by Seabury G. Pollard, in Municipal Engineering, will doubtless be found of interest to many who are directly or indirectly responsible for the efficient management of pumping stations:—

Efficiency may be defined as the ratio of actual performance to predetermined standard performance. It is the elimination of unnecessary waste.

Let us consider an ordinary every day pumping station, such as those in most of our medium sized cities and in many of our larger ones. The buildings are not always practical. The engine room is fairly well equipped, the bright work and the brass bands shine attractively, the floor is fairly clean, not much escaping steam is apparent, there are no cracked steam cylinders, the flywheel is all there, a few records are kept and the engineer is apparently well satisfied with himself and the world in general. The boiler room is usually unattractive. It may be gloomy, dirty and repulsive. Possibly there is an unsightly junk pile in one corner, a dilapidated work bench in another or some broken engine parts under the window. The sanitary arrangements consist of a greasy wash pail and a grimy cupboard. Such conditions are reflected in the employees. The fireman in a listless manner now and then fills the furnace up with coal. He occasionally cleans the fires and takes out the ashes. Possibly more or less steam is escaping through a blownout joint, the heater may be stopped up, the damper will not work, the coal goes on the fire and "the smoke goes up the chimney" just the same and nobody from the manager down considers for a minute that there exist numerous preventable losses all along the line, which in the aggregate may amount to thousands of dollars annually.

Efficient Labor Required.—To avoid such losses it is necessary in the first place to employ only efficient and intelligent labor. In many municipal plants the executive is spared this trouble. The employees are selected for him, either arbitrarily because of their effectiveness in their respective wards and precincts, or through the medium of a civil service board. The first method is bad because the qualifications of the appointees are seldom taken into account. The second is often little better because the examining board is not acquainted with the character of work to be done and is therefore incompetent to judge of the fitness of the men. It does not eliminate political favoritism, and the best qualified men, having no difficulty in getting employment, pay no attention to the examinations. Pre-eminently the person best equipped to select the operating force is the engineering executive.

Operating Standards.—The next important problem before the waterworks operator is the fixing of operating standards. Duty trials of engines and efficiency tests of boilers are, or should be, made shortly after the installation of this equipment. If for any reason such efficiency trials have not been made, or if the results are not available, a competent engineer may be employed to study the conditions existing in the plant, to make such tests as may be necessary or desirable and to establish efficiency standards and proper methods of handling the plant.

* Consulting Engineer, Cincinnati, Ohio, Member of Illinois Water Supply Association.

THE SUPPLEMENTARY ESTIMATES FOR THE CURRENT FISCAL YEAR.

Supplementary estimates for the current fiscal year totalling $23,470,316 were tabled in the Commons, Ottawa, on May 20th, by Finance Minister White.

The most important item in the supplementaries is an amount of $4,000,000 to provide for the construction, leasing or purchase of terminal elevators, as foreshadowed during the discussion of the amendments to the grain act in the Commons.

There is an amount of $1,500,000 for improvement to highways, distributed among the Provinces according to population. The same fate may meet this appropriation, however, as met a similar appropriation last year if the Government again fails to accept the Senate amendments to the highways improvement bill.

For harbors and rivers there is a total vote on capital account of $3,300,000, including half a million each for new Government drydocks at Esquimalt and Halifax naval bases; $200,000 additional for Port Arthur and Fort William harbors; $600,000 additional for Victoria, B.C., harbor, and half a million additional for each of the harbors of St. John, Vancouver and Toronto.

For harbors and rivers in Ontario the important items include the following:—

Armitage Landing, wharf, $8,700; Bowmanville, repairs to piers, $12,000; Bracebridge, wharf, extension and warehouse, $9,600; Burlington Channel, renewal of west part of south pier, $20,000; Burlington, revetment wall, $8,000.

Cobourg, repairs to east pier, $5,500; Cobourg, reconstruction of centre pier, $15,000; Fighting Island (Detroit River), improvement of channel, $57,000; Fitzroy Harbor, wharf, $5,500.

Gananoque wharf, $18,000; Goderich, harbor improvements, further amount required, $8,000; Kagawong, wharf, $5,600; Kenora, wharf, $10,000; Kensington, wharf, $6,000; Kincardine, breakwater, $25,000.

Little Castor River, improvements, $10,000; Meaford, extension and repairs to revetment wall, $33,000; Nation River, improvements, $10,000; Newcastle, repairs to eastern pier, $15,800.

Peterboro', drydock, $25,000; Port Dover, harbor improvements, $50,000.

Port Hope, harbor improvements, $30,000; Rainy River, survey and maintenance of gauges, $16,000; Richard's Landing, wharf and warehouse, $15,000; River St. Lawrence, improvements of Canadian channel between Kingston and Brockville, further amount required, $10,000; Sault Ste. Marie, wharf improvements, $34,500; Severn River at Washago, construction of dams and removal of rocks, $10,000.

Toronto, to pay over two accounts to R. Weddell & Company in connection with new entrance channel to harbor, $22,960; Vail's Point, wharf, $8,500; Victoria Harbor, wharf, $16,000; Wellington, wharf and harbor improvements, $20,000; Whitby, harbor improvements, further amount required, $20,000. Under the item of canals there is an amount of $250,000 additional for construction on the Trent Canal. It is understood that this is to begin the work of completing the northern outlet of the canal from Lake Simcoe. A contract amounting to $1,000,000 is to be let at once.

In addition to the expenditures provided for in the main and supplementary estimates it is to be noted that the Government has yet to bring down the railway subsidies, which will run up, it is expected, well into the millions. There is further expected legislation granting the Canadian Northern Railway, by way of subsidy and loan, of an amount something like $25,000,000.

The Intercolonial Railway calls for an additional expenditure of $756,000 on capital account.

The main items for new public buildings include: $100,000 for a new customs house at Halifax, $70,000 for a new post-office at St. John, $350,000 for a customs house examining warehouse at Montreal, $50,000 for a new public building at Brantford, $150,000 for enlargement of Hamilton post-office, $60,000 for a public building at Sudbury, $300,000 for barracks and drill hall at Winnipeg, $200,000 for Vancouver drill hall, and $100,000 for customs house at Edmonton. The expenditure for public buildings in the province of Ontario amounts to $1,277,655.

The expectation that the Government's supplementary programme for expenditures for this year would be on a lavish scale has been justified. The main estimate calls for an expenditure of $179,152,183, which, added to the supplementaries, makes the total authorized expenditure for the current year $202,622,500. This is an increase of $33,000,000 as compared with the estimates passed by the Government last session.

SIMPLE METHOD OF OBTAINING CORRECT MEAN LINE AND AZIMUTH.

By J. A. Macdonald.*

Necessity is the mother of invention, they say. The writer, being located at the present time (May) in Prince Edward Island, and being far from a town or railway station, and not being provided with the necessary paraphernalia to take direct astronomical observations, resorted to a very simple method, which not only gave at the moment correct meantime, but also azimuth, and both probably more accurate than by the usual methods of hour-angle of Polaris with a transit-theodolite. By the method hereunto described no instrument at all is required; no nautical almanac nor mathematical tables nor formula. There is, however, only one moment in the 24 hours when the trick can be done, and if the sky is hazy it may not be done at all. It requires a fairly clear sky, so that Polaris and another star may be seen in precise range.

The constellation in the northern heavens known as the Great Bear, the Plow, the Dipper or Charles' Wren, is doubtless familiar to all. Two of its five bright stars are known as the "pointers" from their pointing to the North Star or Polaris. The middle star in the tail or handle, as shown in the diagram, is the star which comes to the meridian at the same time as the North Star.

Another bright star comes to the meridian when Polaris is in the same vertical plane with the star Delta (δ) in the constellation Cassiopeia. When both stars are on the same vertical range with a plumb line it is very near the meridian.

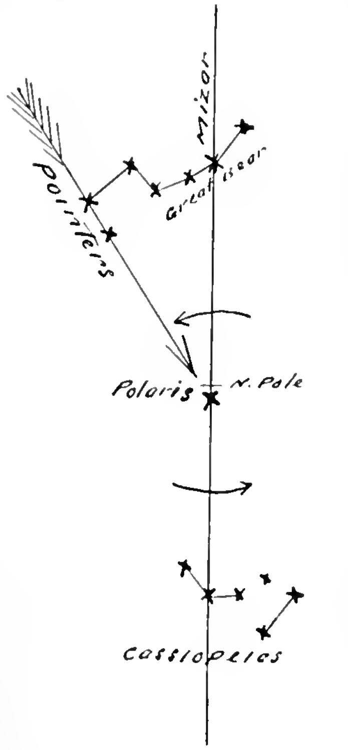
This method is practicable only when the star Delta is below the pole during the night. When it passes the meridian above the pole, it is too near the zenith to be of service, in which case the star Mizar, the last star but one in the tail of the Great Bear, may be used instead.

Delta, Cassiopeia is on the meridian below Polaris and the Pole at midnight on April 10th, and is, therefore, the proper star to use at that date and some two or three months before and after. Six months later the star, Mizer, (Zeta Urs. Maj.) in the tail of the Great Bear, will supply its place, and will be used precisely in the same manner. The method given in this article can not be used with advantage at places below 38° north latitude, neither can it, on account

* Hermanville, P.E.I.

of the haziness of the atmosphere near the horizon, on every night, for it requires a fairly clear atmosphere.

The diagram, drawn to scale, exhibits the principal stars of the constellations of Cassiopeia and Great Bear, with Delta (δ) Cassiopeia, Zeta (ζ) Ursae Majoris (also called Mizar), and Polaris on the meridian, represented by the straight line; Polaris being at lower culmination. This method is given in Lalande's Astronomy and was practised on the Ohio and Pennsylvania boundary with great precision.



Held perpendicular to the line of sight directed to the pole, with the right-hand side of the page uppermost, will represent the configuration of the constellations with Polaris near eastern elongation at midnight about July 10; inverted (in natural position) it will show Mizar of the Great Bear and Polaris on the meridian (the former below and the latter above the Pole) at midnight about October 10; and held with the left-hand side uppermost the diagram will indicate relative situations for midnight about January 10, with Polaris near western elongation. Turned upside down it will show Delta Cassiopeia and Polaris in the meridian at midnight about April 10. The arrows indicate the direction of apparent motion, while the large arrow through the "pointers" indicates position of Polaris at any time.

Finding Correct Mean Time.—Table I.—Begin to watch plumb line for "A" to appear vertically below Polaris:

About—		On line
July 20	5 a.m.	5.30 a.m.
August 20	3 a.m.	3.28 a.m.
September 20 ...	1 a.m.	1.26 a.m.
October 20	11 p.m.	11.24 p.m.
November 20 ...	9 p.m.	9.22 p.m.
December 20 ...	7 p.m.	7.24 p.m.

Table II.—Begin to watch plumb line for "B" to appear vertically below Polaris:

About—		On line
January 20	5 a.m.	5.22 a.m.
February 20	3 a.m.	3.20 a.m.
March 20	1 a.m.	1.30 a.m.
April 20	11 p.m.	11.24 p.m.
May 20	9 p.m.	9.26 p.m.
June 20	7 p.m.	7.24 p.m.

When a plumb line matches "A" or "B" the Pole Star is approaching the meridian and the true local mean time then is the time in column "on line." Interpolate for intermediate days, subtracting four minutes for each day after or adding four minutes for each day before any given date.

Example.—July 25, begin to watch plumb line about 4.40 a.m., and Polaris will be exactly on line at 5.10 a.m. correct mean local time. The interval from July 20 to 25, 4 days multiplied by 4 is 20. This sum subtracted from 5.30, time on line July 20, is 5.10. To change this into local standard time add 4 minutes for each degree west of the time meridian and subtract same for stations east of the meridian. Thus at the point where I write, being 2°15′ west of the 60th standard meridian, 9 minutes must be added to the observed time for standard time. At Toronto add 17 minutes; at Ottawa add 3 minutes; at Winnipeg add 29 minutes; at Calgary add 35 minutes; at Vancouver add 15 minutes, and at Montreal subtract 6 minutes from the standard meridian times at those several places.

To Obtain Azimuth.—Azimuth, or the direction of the meridian can also be obtained directly at the same time and in the same manner.

When the Polaris and Mizar are in line with the observer this line is approximately on the meridian, but a little east of the true line. The North Star is exactly in the meridian 7.15 minutes after it has been in the same vertical plane with Mizar, and may be sighted to after that interval of time with perfect accuracy for 1913. The interval between the time when Mizar and Polaris are on the same vertical circle and the time when Polaris is on the vertical circle through the North Pole is increasing 0.33 minute a year, so that, in 1914 the interval will be 7.5 minutes.

The interval between the time when Delta Cassiopeia and Polaris are on the same vertical angle and the time when Polaris is on the vertical circle through the North Pole is 7.69 minutes for 1913 and is increasing 0.33 minute per year, so that in 1914 the interval will be 8.02 minutes.

A light placed back of the head will aid in seeing the plumb lines which may be hung in a convenient window and let the bob hang in a dish of water to prevent the wind from disturbing the line, or the observation may be made with closed window.

In marking out the meridian, use two plumb lines and connect them by a row of tacks, if the work is done indoors, driven in the porch floor in the range of a pillar, post or window casing.

VISIT OF A PRODUCTION ENGINEER.

Mr. Willis Bell Richards, of the firm of Gunn, Richards and Company, New York City, was a visitor at *The Canadian Engineer* office last week. Mr. Richards is well known in Canada as a production engineer, having been of valuable service upon many occasions to various departments of the Dominion government, as well as to many private corporations throughout the country.

The firm recently opened new offices in the Eastern Townships Building, Montreal, with Mr. H. Victor Brayley as manager for Canada. Mr. Brayley was formerly secretary of the Ottawa Branch of the Canadian Society of Civil Engineers, and held a government engineering position. Mr. James Newton Gunn, the president of the company, is one of the best known production engineers in the United States. He has been connected for many years as lecturer with New York University and the Massachusetts Institute of Technology. The firm employs over fifty trained engineers and also a number of expert accountants, who work in co-operation with the engineers in organizing the shops, offices, buying departments, etc., of industries of all types, in making appraisals and in scientifically analyzing production costs and power costs.

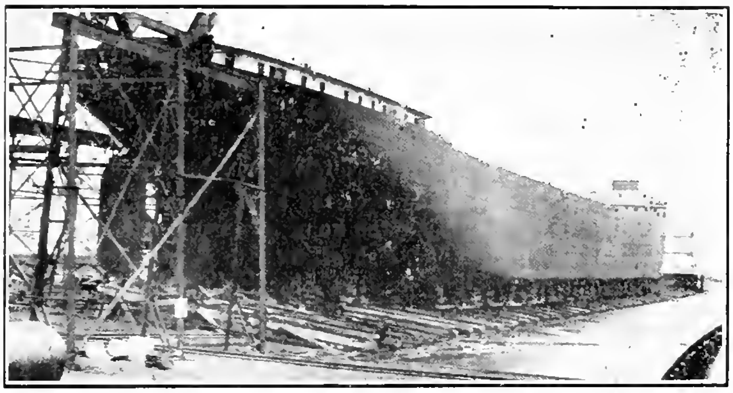
Mr. Richards was called to Canada by one of the leading Canadian capitalists to advise in regard to improving the organization, decreasing the running expenses and increasing the sales of two of the largest manufacturing concerns in the Dominion.

S.S. "JAMES CARRUTHERS."

The launching of the steamship "James Carruthers," which took place a couple of weeks ago at the yards of the Collingwood Shipbuilding Company, marked an epoch in the shipbuilding industry in Canada, in that the vessel is the largest bulk freighter ever built in the British Empire. Some idea of the magnitude of this vessel will be gathered from the photograph accompanying this article, and we are pleased to be able to give to our readers some information regarding the engineering features of this vessel.

The dimensions of the ship are as follows:—Length over all, 550 feet 3 inchs; length on keel, 529 feet; beam moulded, 58 feet; depth moulded, 31 feet, with a carrying capacity of over 10,000 gross tons on 19 feet draft.

The arches and web frames are spaced 12 ft. centres, forming transverse girders, with channel bottom and side frames between, spaced 3 feet centres, plate floors in double bottom on alternate frames. The vessel is constructed witb a complete double bottom, 5 feet deep and side tanks of same width, to height of main deck stringer, for water ballast, and forming a double skin over this portion of the ship to a point above the deep load line, the capacity of these tanks, including the peak tanks, engine-room tanks and deep tank forward being approximately 4,600 tons.



S.S. "James Carruthers" Just Before Launching.

The auxiliaries for handling and manoeuvring the ship are as follows: Steering gear—a 9-ft. by 9-in. quadrant geared steering engine, built by the American Engineering Company of Philadelphia, placed aft on main deck, direct connected by toothed quadrant to rudder stock and controlled from steering stands in the pilot house and on top of same by a hydraulic tele-motor. In addition to this there is an Aker's emergency steering gear, a complete and independent steam gear, placed also on main deck, on port side, direct connected to a toothed quadrant on rudder stock and controlled from steering stand on top of pilot house by jacks and pipe transmission. Steam is always turned on this gear. If any accident occurs to the regular gear, the Aker's gear may be thrown in, in three seconds, by means of a crank on steering stand controlled by the officer on the bridge which, at the same time, trips the regular gear, and throws it out of service for the time being, this gear being a valuable acquisition, where, in the event of a breakdown of the regular gear, in the rivers, without such a device collision or stranding is almost inevitable. Windlass—This is of the Emerson-Walker, quick-warping direct grip type, arranged to handle two four-ton Britannic stockless Bower anchors and 2¾-inch cables, this being the largest windlass of the type ever installed in a lake vessel. The anchors are arranged to stow in pockets entirely within the hull. The balance of deck machinery consists of four 8-inch by 10-inch single drum mooring winches, fore and aft on spar deck; one 8-inch by 10-inch single drum winch in windlass room, and one 8-inch by 10-inch double drum winch on spar deck aft, arranged to handle 3½-inch circumference wire mooring cables, manilla lines being dispensed with for this purpose. The second drum on the after winch is to take the kedge anchor warp, a 4½-inch circumference wire cable, and by means of which the stern anchor, weighing 4,000 lbs., and placed on an inclined platform, may be instantly let go over the stern of the vessel, in case of accident in the rivers, when the stern of the vessel would otherwise in the current swing on to the bank, involving serious risk of damage by collision with other vessels. Two 5-inch by 5-inch single drum hatch winches are located amidships to handle the hatch covers, which are of steel, and are opened and closed by a small steel cable led to these winches. All deck winches were supplied by the Chase Machine Company, of Cleveland.

The navigating outfit is very complete and thoroughly up-to-date in every particular. It comprises repeating telegraph to engine room, with stands inside pilot house and on top, mates' telegraph for docking purposes with stands in pilot house and aft on the spar deck, all with large dials, having additional emergency signals; engine whistle pull inside and on top of pilot house and on each bridge; two sets of main signal whistle pulls, one for emergency use, with levers inside and on top of pilot house; a fog bell, a steering compass in pilot house and standard compass in binnacle on top of house, of Dobbie McInnes make, a helm tell-tale, with indicator on top of pilot house, and direct connected to rudder stock, showing true helm angle at all times, in case of derangement of the telemotor apparatus. There is also installed on top of pilot house, a McNab engine dejection indicator, with direct connection to main engines, showing, by sight in daylight and by sound at night, every movement of the engines ahead or astern. This instrument is a splendid safeguard against the very costly accidents which occur frequently through a mistake in signals between the bridge and engine room. A Morrison trim gauge forms part of the equipment, and a draft gauge, by which the mates can read the exact draft of the ship in rough weather or at night, from an indicator and scale located on forecastle bulkhead forward and on deckhouse aft. A Thomson sounding machine is installed on the spar deck abaft the forecastle bulkhead, with a crane on the bulkhead to handle the sounding device when overboard.

Awnings are fitted over forecastle deck and pilot house, and the usual weather and dust cloths, etc.

There is a complete electrical installation, consisting of two 10-kw. generators with capacity for about 200 lights, being ample accommodation for hold and decks lights and running lights, arranged on separate circuits, and an electric tell-tale in pilot house to give indication of any arrangement of the running lights.

The propelling machinery consists of triple expansion engines with cylinders 24, 40 and 66 inches by 42-inch stroke, supplied with steam by three Scotch marine boilers 15 feet diameter and 11 feet long, 185 lbs. steam pressure and equipped with Howden system of forced draft, developing 2,400 indicated horse-power and designed to give the vessel a speed of 11 miles per hour, loaded, and 13 miles light.

The engines are located directly on the tank top, as far aft as possible, as usual in these vessels, with the boiler forward of this, located athwartships, three abreast on very

heavy saddles and a cross coal bunker forward of fire hold, with capacity for about three hundred tons, and fuel hatch fitted in tank, above spar deck.

The engines are handled from a working platform, below main deck level, of convenient height to suit the levers, with dynamo room abaft this. Great care has been taken in laying out the engine room to ensure ample working space and at the same time studying the comfort of the engineers' crew.

The pumping equipment comprises one centrifugal and two duplex pumps located in the lower engine room to take care of water ballast, sanitary pump and deck pump, one duplex main feed, one duplex auxiliary feed and fire pump on upper engine room floor and air, bilge and cooler pumps direct connected to engine, also hand bilge and fire pumps forward and aft.

A refrigerating machine having capacity of three tons in 24 hours, by Kroeschell Bros., Chicago, is located in the upper engine room, and piped to refrigerator in the deckhouse above, this being fitted with cooling coils and also an ice door, opening on spar deck, for use should a supply of natural ice at any time be required.

TRAFFIC THROUGH THE SAULT STE. MARIE CANAL.

The annual statistical report on lake commerce passing through the canals at Sault Ste. Marie, Mich., and Ontario during the season of 1912 has been issued by Lieut.-Col. Mason M. Patrick, of the U.S. Army Corps of Engineers. The total freight traffic through both the American and Canadian canals, of 72,472,676 short tons for the season of 1912, shows an increase of 36 per cent. over the previous year. All items of freight show an increase except coal, salt, copper and building stone. The season of navigation continued for a period of 7 months and 26 days. The traffic through the American canal was 45 per cent. of the total freight and 55 per cent. of the total net registered tonnage, while the traffic through the Canadian canal was 55 per cent. of the total freight and 45 per cent. of the registered tonnage.

Of the total traffic 55,377,687 short tons was eastbound, and 17,094,989 was westbound. The transportation charges, including loading and unloading, on freight passing through both canals were $40,578,225.40.

The total expenditures for operating and repairs on the American canal for the year 1912 are given in the report as follows: Operating, $71,135.66; repairs, $81,061.68; total, $152,197.34. The cost per freight ton was 4.64 mills.

MEDICINE HAT'S STREET RAILWAY.

Medicine Hat ratepayers have sanctioned a by-law giving an exclusive franchise to the Montreal Engineering Company to operate an electric street railway in the city. The franchise is for a period of 25 years. Work is to commence immediately on the construction of the plant.

The Montreal Engineering Company, which has secured the franchise represents Sir Max Aitken and his associates and is the company which built the Porto Rico railways, the Demerara Electric, the Camaguey Company and the Trinidad Electric. It numbers among its directors Messrs. R. O. Sweezey, A. R. Doble, F. P. Jones, Fred C. Clarke and Victor Drury.

PRESERVING FENCE POSTS FROM DECAY.

Wood-rot, in all its forms, is due to the action of fungi working under suitable air and moisture conditions. In fence posts these conditions are most favorable at or near the surface of the ground and hence it is there that decay first starts. Some woods, like the cedar and tamarack, are more resistant to fungus attack and may last, as fence posts, from eight to ten years. Unfortunately, however, the supply of these woods has grown very scarce, and one is faced with the alternative of importing durable material at a high price or of applying preservatives to the common non-durable woods which grow in his own wood lot. As the latter alternative is not only cheaper, but also much more effective, it is of considerable economic interest to know how these wood- preservatives are applied.

Creosote, a "dead" oil of coal tar, is perhaps the best preservative for this purpose, as it does not dissolve out of the treated wood, when in contact with moist earth. It costs from eight to fifteen cents per gallon.

There are two methods of applying the creosote, but before either method can be applied it is necessary to have the posts well seasoned if the best results are desired. This seasoning is best accomplished by peeling the bark from the posts and then stacking them in loose piles in the open air for several months, so the amount of water in the wood may be reduced to the smallest per cent. possible.

The brush method consists in applying the creosote like a coat of paint to the lower portion of the post, up to a point six inches above the ground line, the creosote being first heated to one hundred and eighty degrees Fahrenheit. Two or more coats may be applied, time being allowed between each application for the creosote to soak into the wood.

What is known as the open tank method, while more expensive, secures deeper penetration and gives better results, especially when the posts are split or checked. The creosote is heated to boiling point in a metal tank and if such is not available, a simple and effective apparatus can be made by boring two holes, about two feet apart, in the lower half of one of the staves of a watertight barrel and screwing into these holes two pieces of iron piping three to four feet long which are connected by a shorter vertical pipe with two elbow-joints, thus forming a complete circuit somewhat resembling the handle of a mug.

The barrell is then filled with enough creosote to cover both upper and lower pipe holes and a fire is kindled under the lower horizontal pipe which heats the creosote in the pipes and creates a circulation which continues until all the creosote within the barrel is at boiling point. The posts are then placed in this boiling liquid for about five hours, after which they are immediately transferred to another barrel of creosote, or else the fire is put out and they are allowed to remain in the tank until the creosote becomes thoroughly cooled.

In this process the preliminary heating drives some of the contained air out of each wood-pore, and when the posts are allowed to cool in the creosote, a partial vacuum is then created in each pore which draws the creosote into every fibre. Poplar posts, which ordinarily last but three to four years, after the above treatment will last twenty years, and the same applies to all other tree species in Canada. All that is essential is thorough seasoning before treatment. Further information on this subject can be obtained on application to the Forestry Branch, Ottawa.

RAILROAD TIMBER-TREATING PLANT.

By F. J. Angier.*

The Baltimore and Ohio Railroad has put into operation a new timber-treating plant, which has just been completed at Green Spring, W. Va. The new plant is one of the most complete and modern timber-treating plants in America. It covers sixty acres, and is situated close to large areas of timberland along the South Branch Valley of the Potomac River. The requirements of the Baltimore and Ohio system approximate 2,500,000 ties annually for renewals, and with the new plant in operation a large proportion of these ties will be treated by the company. Other timber for railroad use will also be treated at the plant.

The timber-treating plant is equipped with two treating cylinders, or retorts, as they are commonly called. These retorts are seven feet in diameter and 132 feet long, made of ¾-inch steel, and built for a working pressure of 175 pounds to the square inch. Each of the retorts rests on nine concrete piers, and is securely anchored to a centre pier with six 1¼-inch bolts. On the remaining eight piers the retort rests on cast-steel saddles, and placed between the saddles and an iron plate embedded in the concrete are nests of steel rollers, each nest being made of three rollers two inches in diameter and ten inches long.

At each end of the retort is a door which swings on steel rollers, and can be opened and closed easily by one man, notwithstanding the weight of 6,400 pounds each. The door consists of a steel frame with flanged steel dished head one inch thick. The retorts are equipped with heating coils, and also with perforated pipes. The pipes are used to obtain a more perfect distribution of steam when green timber is being artificially seasoned, as well as for the circulating device used in the card process.

The main building of the plant is of steel frame construction, with corrugated iron sides and concrete roof. The floors of the building are of cement, and a concrete basement so constructed that should any of the preservative be spilled it can be recovered. In the basement is a concrete sump equipped with an electric device which indicates to the engineer in charge that the sump is filled. The sump is emptied by means of an ejector, the liquid passing into a settling tank about 50 feet from the building. The settling tank is also of concrete construction, with dimensions of 20 feet in width, 50 feet in length, and approximately 10 feet in depth. The tank has four compartments, and after the drainings from the plant enter the first compartment the liquid is forced to travel through each of the other compartments in a circuitous path to the last compartment. By this time any creosote carried from the plant falls to the bottom, because of its greater specific gravity, and enters a well in the bottom of the last compartment of the settling tank. Here a bilge pump, operated by electricity, picks it up and carries it to an underground tank, and then by compressed air it is carried into the working tanks.

The boiler-room is situated adjacent to the main building, the dimensions of the room being 30 feet by 40 feet. The boiler-room contains two horizontal return tubular boilers of 150 horse-power each, built for 125 pounds working pressure per square inch. Space is provided in the room for a third boiler to be installed when the requirements of the railroad justify the enlargement of the plant. A boiler-feed heater, injector and feet water pump complete the equipment in the boiler-room.

The oil storage tank is 40 feet in diameter by 30 feet high, having a total capacity of 280,000 gallons. There is also a storage tank for a concentrated solution of zinc-chloride, the dimensions of which are 15 feet in diameter by 20 feet high, with a capacity of 25,000 gallons. The oil storage tank is equipped with a system of heating coils made in four sections, the combined heating surface of which is 500 square feet. An angle stem thermometer is placed in the side of this tank to enable the oil being kept at a constant temperature of about 120 degrees Fahrenheit.

Near the storage tank is an underground unloading tank, 6 feet in diameter by 60 feet long. The tank is enclosed in a concrete pit, which will prevent waste of the creosote in the event that leakage occurs. The tank will withstand an air pressure of 50 pounds per square inch, and creosote is forced from this tank into the storage, or working, tanks by air also. The working tanks and pressure tanks are all located inside the building, so that they can be kept warm and the temperature of the working solution retained at 190 degrees. The locating of these tanks inside the building also accomplished a further economy in the consumption of fuel, particularly in cold weather.

The working tanks are 24 feet in diameter by 20 feet high, each having a capacity of about 68,000 gallons. They rest on concrete foundations six feet above the floor line, being equipped with cast-iron radiators for heating the solution. Each tank has three sets of radiators, working independently of one another. The combined heating surface of the radiators is 441 square feet. Each tank is also equipped with air coils for agitating a mixed solution of creosote and zinc chloride. Air is admitted at 100 pounds pressure, and distributed in such manner as to completely mix the solution in from two to five minutes. The tanks are also equipped with mercury gauges, which show the true reading in tub feet and gallons, regardless of the temperature. This avoids the necessity of making correction for temperature readings with these gauges. Besides the mercury gauges, each tank has a syphon regulator, which regulates the steam supply to the radiators and automatically opens and closes the steam supply valve in maintaining the required temperature.

The pressure tanks are 8 feet in diameter and 14 feet high, made of ⅞-inch steel for a working pressure of 175 pounds. They are in reality a combination of pressure, measuring and drain tanks, and are located in such a way that they are readily filled while the treating cylinders are being filled preparatory to treating a charge of timber. Compressed air is then applied through the top of these pressure tanks, and the preservative is forced through a pipe in the bottom connected with the cylinders. Pressure is maintained until the required absorption is obtained in the timber, after which the valve is closed, and any preservative remaining in the tank can be returned to the working tank by means of the compressed air already in the pressure tank. There is also a sufficient amount of compressed air in this tank to force all of the solution in the treating cylinder back to the working tank. The tanks are also used for measuring purposes, being equipped with mercury indicators, which show the amount of solution, and thus informing the engineer as to the amount of solution going into the timber he is treating. They are also used as drain tanks to catch and measure the solution taken from the timber during the vacuum and draining process. The bottoms of the pressure tanks are only slightly lower than the treating cylinders; and, though all of the drainings from the charge would not flow into the pressure tank by gravity, this is easily and quickly accomplished by admitting atmospheric pressure to the treating cylinder while the pressure tank till maintains a vacuum. This combination of pressure-measuring-drain tank is entirely unique with the plant at Green Spring. It was worked out by the writer, assisted by Card and McArdle, who were the draftsmen in getting out the pipe plans. It eliminated entirely the dirty and ex-

* Superintendent of Timber Preservation, Baltimore and Ohio Railroad System.

pensive pressure pumps commonly in use in timber-treating plants

Recording gauges and recording thermometers are connected to the treating cylinders. This places the superintendent in complete touch with the treatment in all of its details, the charts indicating the temperature, pressure and vacuum recorded for every moment the plant is in operation.

The plant is heated throughout by steam, the vacuum system being used, all condensation being returned to the boiler-feed heater and thence to the boilers. A 50-kilowatt generator furnishes the light for the plant and the yard, there being three arc lamps and about 50 incandescent lamps in the system. The electric plant also furnishes current to operate two 10 horse-power centrifugal pumps and a single horse-power bilge pump. The centrifugal pumps are 8-inch ones, used to circulate the mixture of creosote and zinc-chloride in the retorts while using the Card process. The latter is in the settling tank and is used to pump creosote, that may have settled out from the drainings, into the underground unloading tank.

An experimental plant is situated adjacent to the main building. This plant consists of a complete physical and chemical laboratory. The experimental cylinder is 30 inches in diameter and 9½ feet long, or large enough to hold three or four ties. There are two working or pressure tanks, underground drain tank, pressure pumps and electric centrifugal pump. The tanks are equipped with the latest gauges and thermometers, and the entire plant is so designed that any process can be used, and pressure can be supplied as high as 300 pounds. The chemical laboratory adjoins the physical laboratory, and creosote distillations, zinc-chloride analyses, etc., will be made.

The office building is of concrete, and is fireproof in its entire construction. The same is true of the other buildings in the plant. The hose and engine-houses are of wood, but these are small and located some distance from the other buildings. A fire system has been installed as a protection against destruction in this way, and a fire department will be organized from among the employees, the organization of which will be similar to that at the large terminals, shops and other centres on the Baltimore and Ohio system. A 6-inch water main has been laid the entire length of the tie-yard, and every 300 feet there is a hydrant. The hose-house is near the office, and is equipped with a reel of 300 feet of hose. Water pressure for fire emergency is maintained by a high 50,000 gallon water tank, kept filled at all times.

At the present time the water used in the timber-treating plant is being pumped from the Potomac River, but this arrangement is but temporary until a permanent water system can be built for the joint use of the timber-treating plant and for supplying water to locomotives in train service. The permanent water plant plan calls for two pumps, located at the plant in a concrete well about 100 feet below the surface of the ground. The depression was deemed necessary on account of the lift from the river. Water will be pumped into the high storage tanks and fed by gravity throughout the plant and yard.

Practically all of the ties treated at the plant to date are oak, the number being approximately 200,000. The standard tie in use on the Baltimore and Ohio is 7 inches by 8 inches and 8½ feet long, containing 3⅓ cubic feet. These ties are unloaded and cribbed in piles of seven and one, and are handled by piece-work. It is the intention to air-season all ties. However, if they are not received in quantities sufficient to properly air-season, the plant is designed to take care of this by giving a preliminary steaming and vacuum before the injection of preservatives.

All storage yard tracks have three rails, the outside pair being of standard gauge and the inside rail fixing a 30-inch gauge for the tram cars. In loading for treatment the ties are classified as hard and soft woods and as No. 1 and No. 2. For this work the men are paid at a rate per tram instead of per tie, as is the case of unloading and cribbing for seasoning. Thus it makes no difference whether there are 30 or 40 ties on a tram; the cubical contents are practically the same, and the amount paid is the same. There are 130 tie-cars used to deliver the ties to and from the treating cylinders.

The location of the timber-treating plant is believed to be admirably suited for all purposes, being in near proximity to large timber areas. Green Spring is at the junction of the Romney branch with the main line of the Baltimore and Ohio system. The Romney branch, which extends 16 miles to Romney, W. Va., and the Hampshire Southern Railroad, extending 38 miles farther to Petersburg, tap a timber tract of several thousand acres, much of it being virgin timber. The outlet for all timber adjacent to the lines mentioned is by way of Green Spring, and in marking the timber it is in reality merely a question of stopping the timber at the plant to have it seasoned and treated.

THE R. M. S. "KYLE."

The R.M.S. "Kyle," which has been built and engined at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, to the order of the Reid Newfoundland Company, of St. John's, Newfoundland, went for a very successful trial trip on Monday, the 5th inst.

The steamer is a finely modelled screw vessel of 220 ft. in length by 32 ft. beam, exceptionally strongly constructed for running through ice which she will often meet on her mail and passenger service on the Newfoundland and Labrador coast.

The passenger accommodation is amidships for the first-class passengers. These are 68 in number, and have a large smoking room on the promenade deck, a dining saloon and music room on the upper deck, and state rooms, including a ladies' room on the main deck.

The second-class passengers are placed aft in two compartments on the main deck, one for men accommodating 102, and the other for women, with sleeping accommodation for 39.

The captain's house is on the promenade deck, the other officers and engineers are in rooms at the sides of the engine casing, and the seamen, firemen, and stewards are forward.

The steamer is provided with a complete installation of electric light, including a search light, an efficient arrangement of steam heating suitable for the climate, and wireless telegraphy.

The propelling machinery consists of a set of single screw triple expansion engines, supplied by steam from two large boilers working under Howden's forced draught, the whole having been constructed at the Neptune Works. On the trial trip they worked without the slightest hitch, giving satisfaction to all concerned, and driving the vessel at a speed of 13¾ knots per hour.

The owners were represented by Mr. R. G. Reid, one of their managing directors, and the builders by Mr. G. F. Tweedy, one of the managing directors of Swan, Hunter and Wigham Richardson, Limited.

DESIGN OF STRUCTURAL STEEL PLANT.

E. H. Darling, C.E., A. M. Can. Soc. C.E.*

General Conditions Controlling Design of a Plant of 10,000 Tons a Year Capacity.—A plant for the fabrication of structural steel for the Canadian market must be equipped for a wide range of work, for, while higher efficiency can usually be attained by specializing on one class, it is not always possible to do so for the following reasons:—

(1) Contracts of a uniform nature cannot always be obtained; and,

(2) Almost any contract has more or less variety of work involved in it.

Certain classes of work, such as building and highway bridge work, are required during the summer months only, while railway work can be done all the year round. By properly combining the two classes there will be less chance of slack seasons for the shop.

Location.—The location of a structural steel plant is subject to the same general principles that influence other manufacturing enterprises, and, while there may be many secondary conditions that will have more or less weight, the four main ones are: (1) The market; (2) the supply of the right class of labor; (3) access to raw material; and (4) the supply of power.

1. **Market.**—The market for structural steel depends on the class of work sought. Railway work is so widely distributed that good railway connections are of more importance, within reasonable limits, than location. Freight rates do not necessarily enter into the question, as the railways haul all such material and erection equipment, which is for use of their own roads, free of charge. For this reason, as well as others, connection with several railways is desirable. For mill building work, the greatest demand will be in industrial centres, although much of the same class is used in large public buildings, such as armories, churches, auditoriums, rinks, etc. For beam and general building

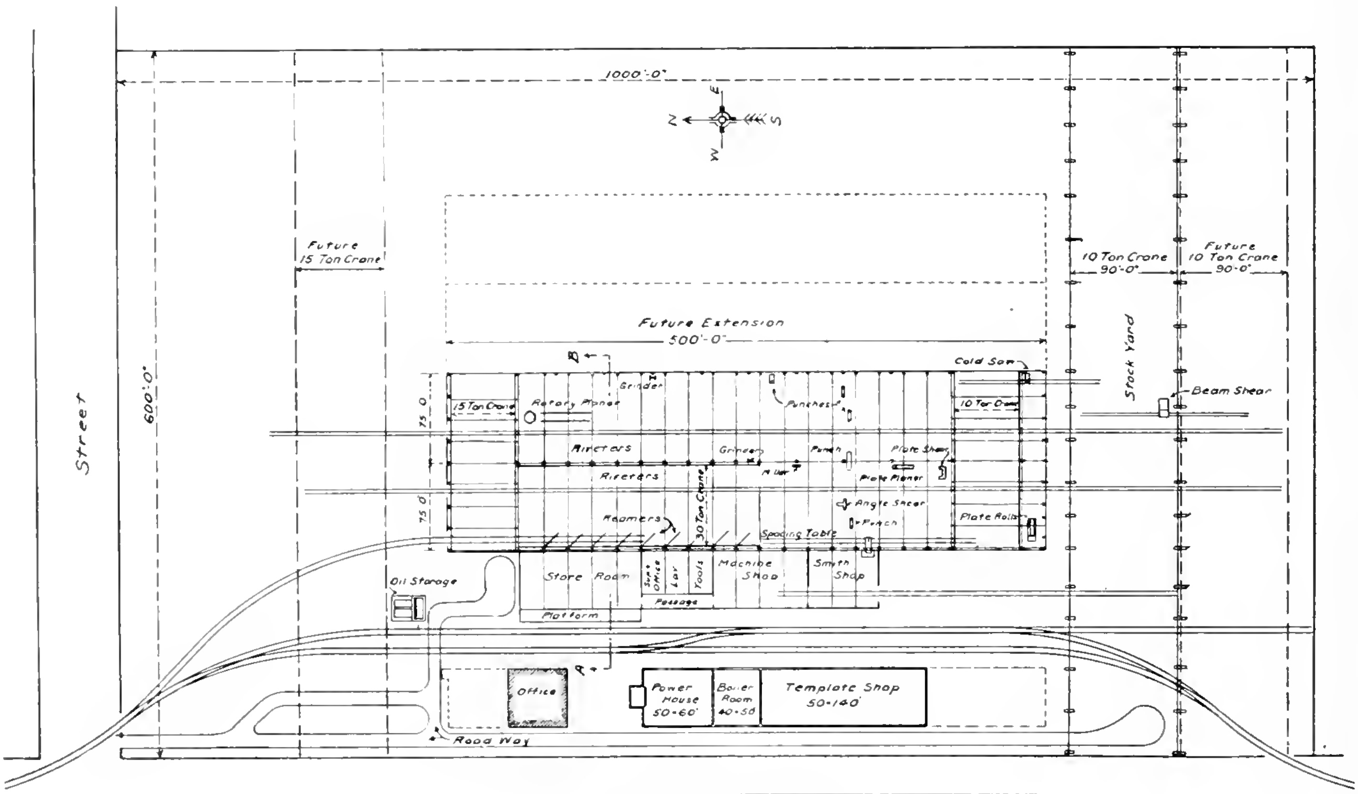


Fig. 1.—Showing Ideal Layout.

But apart from this, as the plant is a new one, whose market is not assured, it should be laid out with the idea of doing general work, and then, as the company finds its place in the business of the country, it may develop those lines which prove to be most profitable.

To secure this desirable flexibility of capacity in a plant having an output of 10,000 tons a year, it will be found advisable to have two main departments: first, a structural shop for all kinds of light truss and beam work, with facilities for handling pieces of five to ten-ton weight. Second, a girder shop where fifty-ton girders can be handled economically. A plant constructed on these lines, with all the necessary subsidiary departments, will be able to turn out any type of railway bridge up to 300 feet in span, and at the same time can be operated efficiently on any ordinary light work.

work, such as building contractors require, large commercial and business centres are the best markets. As most of such material has to be transported by team to the building site, good roads are necessary to handle this business. Steel highway bridges are required to replace old spans in the well-settled rural districts, or for new bridges in rapidly growing sections.

In finding the "centre of gravity" of a market, i.e., the point from which it will be possible to serve the largest number of customers, freight rates and cost of transportation should be considered rather than distances. For various causes, due to questions of competition and peculiar conditions existing in Canada, it will often be found that it costs more to make a shipment to a nearby place than to one at a greater distance. From a shipper's point of view, therefore, the latter place is nearer than the former.

The value of a market, however, depends largely upon the amount of competition that will have to be met; so in finding the centre of gravity it will be necessary to assign

* McPhie, Kelly & Darling, architects and engineers, Hamilton, Ont.

"weights" to various cities or districts according to how well they are served by existing companies.

2. **Labor.**—The cost of labor in the manufacture of structural steel is such a large percentage of the total cost that the question of obtaining a sufficient supply of the right kind deserves careful consideration. It will be necessary, in the first place, to secure experienced foremen and leaders, and these can only be obtained from other plants. With these as a nucleus it will be possible to train up intelligent laborers to do a great deal of the work, but, owing to the changes that are constantly taking place in a large organization, there will always be a need for men who have had some experience in a structural shop. Such workmen can more readily be obtained at some point near or in easy reach of other structural plants, while at other points it will be necessary to have a well-organized employment department to look after this. As many as two hundred men will be required to operate the plant, who, with their families, may mean that one thousand persons will be supported by it.

Raw Material.—Apart from a small amount of machine shop supplies, such as any manufacturing concern uses, "raw material" means only one thing in the structural steel business, and that is the rolled steel plates, beams, angles, etc., used in fabricating. There were over 600,000 tons of steel imported into Canada last year and by far the larger part of this quantity was in the form of structural material. Most of this comes from the United States, with Pittsburg as a centre. European manufacturers are at a great disadvantage in competing for this trade, because ocean transportation means more handling and serious limitations to the size and length that can be shipped.

It is of great convenience to a structural steel company to be as near as possible to its source of supply. Not only will it mean a big saving in freight rates at times, but what is often of more importance, it will save delay in getting material, and when mistakes are made in shipments they are more easily remedied.

The further removed a plant is from its source of supply the more necessary it is that a stock of material be carried. This requires a lot of capital, but, as a rule, it will be found very profitable, as well as a great convenience.

Power.—Compared with many other lines of manufacture, a structural steel plant does not need as much power in proportion to its output, and in this case not more than two hundred and fifty horse-power will be required. The most convenient form for it, as will be shown below, will be in electrical energy, and it is usually easy to obtain it in manufacturing centres. But it may happen that an otherwise desirable location does not offer this advantage, and then a power plant will have to be installed. This will mean the investment of extra capital and an increase in operating expenses, which must be taken into consideration.

There are a great many secondary conditions that influence a choice of location, such as climate, special inducements from municipalities, personal preference, etc., which will all deserve careful consideration, but it must be remembered that a mistake made at this stage will handicap the industry for all time.

Choice of Site.—An ideal site for a structural steel plant is not readily obtainable. A large area is essential, even for a comparatively small plant, while ample provision should be made for growth. Judgment must be used in this particular. Too much land might be a burden to a new company, or, on the other hand, a valuable investment. It should be level and have a water supply and good drainage. It must have at least one railway connection, and more if possible. For immediate neighbors it is convenient to have other iron industries, for these not only supply the smaller items of raw material, but tend to create a larger labor market. The site should be convenient to the homes of the working men, for, apart from the question of wages, no one thing has a greater influence on the problem of building up a permanent and efficient organization than this.

It is not necessary to discuss all the possible variations that may occur and yet give a satisfactory site, for such things as the shape of the lot, the location and number of railway connections, position of streets, etc., make each site a special study. The necessary, or, at least, very desirable features are:—

(1) Sufficient room to arrange the switches and buildings conveniently, leaving ample room for extensions.

(2) A storage yard at one end of the plant where cars may be unloaded and material stored.

(3) A corresponding area at the other end, smaller in extent, to serve as a storage yard for finished work, with facilities for loading it for shipment.

An Ideal Layout.—Fig. 1 shows an ideal arrangement for a structural shop on a lot of fourteen or fifteen acres, six hundred feet wide and one thousand feet long, lying north and south. A railway, from which switches can be made, is assumed to run along the west side, and a public street at the north end. The outstanding features of this plan are as follows:—

The buildings are placed approximately near the centre of the lot, leaving the ends clear for stock and shipping yards. The office, power-house and template shop, which will have to be of a permanent type of construction, are placed along one side of the lot, where they will not interfere with future extensions of the plant. The storerooms and the smaller departments are arranged along the permanent side of the main building for the same reason. The east side is left clear for additions.

The service tracks are brought in between the buildings so that supplies and materials may be readily unloaded just where required. It will be of great convenience to have two connections with the railway as shown. A double track permits the passage of cars, and gives as well more storage room for them. A cross-over between the tracks will be of great service. One track should be run into the shop under the travelling cranes, so that long and heavy pieces may be loaded directly on the cars. It is very necessary to have easy curves on this, for long girders, loaded on several cars, will be brought out over this track. For this reason, and because heavy locomotives cannot take sharp curves, the degree of curvature should be kept as low as possible. The curves shown have a maximum of 20°, which should be considered the limit. At some future time another track may be put along the west boundary, where cars of the erection department may be stored when not in use.

Regarding the arrangement of the various buildings and departments, it will be noted that the office is placed so as to be the first building approached on entering the plant. Room is left for building on a new front when larger and more elaborate offices are required. The power-house boiler-room and template shop can conveniently be placed in one building, divided by fire-walls, or in a series of buildings. The south end of the template shop may have a temporary end, which will allow it to be extended if necessary, but the power-house and boiler-room should be made of good proportions, as it will not be possible to enlarge these buildings conveniently.

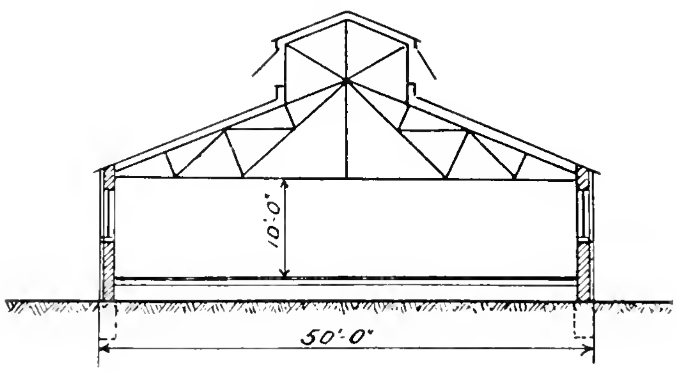
This arrangement places the power-house near one boundary of the site, so that high voltage power lines may be brought into it in such a way that all danger of accident from contact is eliminated. At the same time it is at a central point from which it is convenient to distribute the

power to all parts of plant. A small tower at the north end of the power-house forms the transformer room, and the main switchboard may be placed along the wall between this tower and the engine-room.

As the plant will probably be run by electrical power purchased from a power company and not generated at the plant, the boiler equipment will be largely used for heating purposes only. The buildings requiring heat will be the office, power-house, template shop and machine shop, and these are grouped around the boiler-room so as to make the distribution system very simple.

Templates.—The product of the template shop is used altogether at the south end of the main shop, where the "markers" do the laying out. It will be desirable, therefore, to have the template shop as convenient to the markers as possible, as shown on the plan. It will also be in easy reach of the drawing office, which is over the business office.

On the other side of the tracks, convenient for receiving and shipping (and also at the permanent side of the plant), are placed the storerooms, machine shop, rivet and bolt shops, and the blacksmith shop. These departments are relatively small compared with the rest of the plant, and the space allotted should be quite ample for all requirements. Extensions, however, may be added at either end, and the partitions between these departments may be made of temporary construction so as to be easily re-arranged should it be found desirable to make any changes in the future.



Template Shop

The position of the storeroom, with its platform along the tracks and road in from the street, permits supplies to be readily handled. Its proximity to the machine shop, rivet shop and blacksmith shops will save time in transporting materials to and from these departments. As far as the main shop is concerned, the largest item drawn from the storeroom will be rivets and bolts and those are used entirely by the assemblers and riveters at the north end of the building. The storeroom is made of good size as by far the larger part of the room will be taken up by bulky equipment for the erection department.

The main shop consists of two seventy-five-foot aisles, one for heavy girders and the other for general structural work. As it will be the structural department that will require to be extended in the future, the girder shop is placed next the storeroom and the way is left open for adding two more aisles to the structural shop. Putting the girder shop in this position makes it possible to bring the railroad track into it.

Buildings.—The office building, power house and template shop should be substantially constructed so as to be warm, dry, and fire-proof. The office will be two stories high, the second story being occupied by the engineering staff. The power house and template shop will be a one-story brick building having a monitor, as shown on the cross section, Fig. 2. The roof is of 2-inch concrete carried on steel purlins and trusses. The windows which take up a large part of the wall space, will have steel sash. The monitor windows will be on hinges so they can be opened, and sections of the other windows will also be made to open. The floor of the power house will be concrete. The template shop floor will be raised eighteen inches or so above the ground level and be of 4-inch mill construction with an upper floor of inch white pine. This makes a good floor for laying down work upon.

The type of construction to be followed in the main building is shown on the cross section. A large percentage of the exterior walls as well as the monitors will consist of windows which will insure good illumination throughout. The balance of the wall area will be corrugated iron, with the exception of the eight feet below the first row of windows. This will be made a 9-inch brick wall on the north, west and south sides of the building with a concrete window sill to finish it off. This brick wall will make the building much more comfortable, both winter and summer.

For the roofs of such buildings as are subject to considerable deflection as well as vibration, and shock, it is preferable to use 2-inch matched wood sheeting rather than concrete. As the roof is flat, the covering may be 4-ply felt with tar and gravel.

The frame work will be steel throughout and entirely self-supporting. Steel sash will be used for the windows, as it is only by its use that the large windows can be had.

In dimensions the main building is two hundred feet wide and five hundred feet long. It consists of one fifty-foot and two seventy-five-foot aisles with a sixty-foot transverse aisle at each end. An economical length of bay will be twenty feet. The clearance between the bottom chord of the truss and the floor in the seventy-five-foot aisles should be twenty-one feet to allow for air hoists, etc. In the transverse aisles and the girder shop additional head room will have to be provided to allow for travelling cranes. By making the roof at these points as high as the roof on the monitors a good appearance will be obtained. In the machine shop aisle, fifteen feet will be sufficient clearance. Too much height here means a more difficult building to heat, and longer belts for belt-driven machinery.

All trusses whose bottom chords are at the fifteen and twenty-one-foot level should be designed to carry two five-ton trolleys without danger. Use a factor of safety of five for one trolley and of three for two trolleys. For the roof live load at least fifty pounds per square foot should be provided for and, for certain localities where the snow fall is unusually heavy, the live load should be increased. Where there is any possibility that a column will have to carry a jib crane, provision should be made for it in the original design. This refers to the columns in the girder shop where those along the west wall will have to take radical reamers, while five-ton travelling jib cranes for riveting machines have to be supported by the east side. Particular care should be taken with the design of the bracing for the building, and the bottom chord system should be especially heavy to tie the whole structure together rigidly.

To facilitate the transfer of material from one aisle to another the interior columns in the structural shop should be so arranged that the bottom chords of the trusses form one continuous trolley runway from one aisle to another. This is done by spacing the columns forty feet centres and placing them in the middle of a bay, carrying the roof trusses on longitudinal trusses between these columns. The east wall is filled in with temporary columns to carry the girts

and siding. These can be moved further east when another aisle is added.

It will be necessary in order to attain economy in shop work, to floor the main building. All things being considered, it will be found that a wood floor will be comfortable for the workmen, reasonably durable, easily repaired, and as cheap as any in first cost. On account of the enormous loads the floor will have to sustain and the rough usage it will receive, it should be made of 3-inch red or white pine. Nailing pieces or stringers of 4 x 4 timber should be bedded in cinders thoroughly rammed and smoothed flush. These pieces should be spaced from three to four feet apart. Every precaution should be taken to keep the sub-floor perfectly dry and if there is any possibility of the wood getting damp, it should be treated with some kind of preservative before laying.

Machinery Equipment.—The machinery equipment of the plant is probably the most important question to be considered. Not only does the output of the plant depend on it, but a large proportion of the capital of the company may be invested in equipment and, unless every department is nicely balanced, more or less of it may be unproductive much of the time.

The manufacture of structural steel work requires in its operations the straightening, cutting, shearing, punching, assembling, reaming, riveting, milling and general finishing of a large number of different steel sections.

It would, therefore, be necessary to provide at least machinery for these operations. But the capital invested in a manufacturing plant is subscribed with the expectation of it being able to turn out a certain amount of work which will net a certain percentage of profit. So it will be necessary to have enough machines of each kind to make the capacity of the plant what is desired. For reasons mentioned above, the proportion of each class of work varies widely with different contracts. It therefore becomes a matter of experience and judgment to fix on the amount of equipment to install, as the most careful figuring is at best very approximate. The first item which it is well to fix is the number of riveting machines required. From this the number of punches may be decided upon, and the rest of the equipment proportioned accordingly.

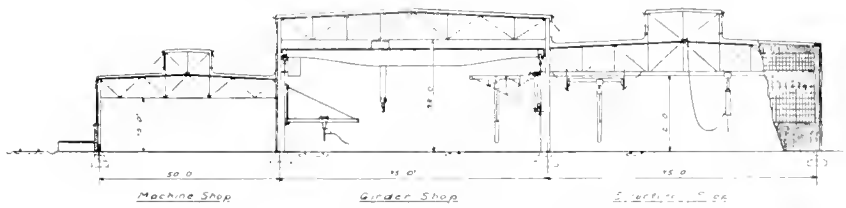
In purchasing machinery certain general rules should be observed. It will be found advantageous in the long run to buy machines having a rated capacity well above the average demand that will be made upon them. Besides the fact that the heavier machine will be more durable, it will in some cases give the plant equipment for a wider range of work at comparatively little extra cost. At the very least it will provide for an emergency which otherwise might prove very expensive.

If the demand for a certain machine product varies widely it will some times be found economical (when the cost of operating a large machine is high) to have two smaller machines instead of a single large one, the first with sufficient capacity for the average requirements and the second capable of taking care of the extraordinary demands. As the plant spreads out, duplicate machines may be required at different locations, it being cheaper to operate two machines than to transport material long distances to have work done upon it.

While complicated machines are to be avoided, it will save capital at the start to buy machines that may be changed over for different classes of work, provided they are not in constant use. For example, the plate rolls should be made a combination of bending and straightening types. The punches should be made so that either cross-cutting or splitting shear blades may be put on to replace the punch and die. The light riveting machine should have one or more extra interchangeable stakes to be used for column or other special work. In this way, at the cost of the extra parts and the time it takes to make the change, work could be done that would otherwise require two separate machines, one of which would probably be idle most of the time.

The matter of punches, shears, reamers, riveting machines and other machines might be taken up at this stage. Their capacities, accessories and other outstanding features are in line for careful attention, but the discussion of these items is a little removed from the province of this preliminary investigation of the general lay-out itself, and will not be discussed.

Arrangement of Machinery and Routes for Material.—The arrangement of the machinery and the establishing of the routes for the material to pass through the shop is one of the most difficult and perplexing problems in connection with the design of a structural steel plant. In theory the material should enter one end of the shop and pass through it from one department to another, emerging at the other end as finished product, without having once been turned around or carried back over any part of its route. In practice, however, there is such a variation in the order in which the work has to be performed—due to details of design and special requirements—that no fixed route can be maintained. At best a material route can be laid out only in a general way, observing the following principles:—



Section on AB see Drawing

Arrange the plant for that class of work which promises to be the most plentiful. If it is necessary that some material be re-handled, let it be the shorter and lighter pieces rather than the long heavy ones.

Sufficient space, sixty-five to seventy feet in the longitudinal direction of the shop, should be left between machines so that, under ordinary circumstances, there will be no crowding or interference. Material over seventy feet in length may be considered very unusual and when, on rare occasions, it becomes necessary to take care of it, more or less difficulty and interference may be permitted. To design the whole plant for it would add very materially to the cost of buildings, while the increase in the distances that the shorter material would have to be transferred would add to the cost of operation of the plant on regular work.

The material will be sorted out in the stock yard and any with kinks or sharp bends in it will be taken directly to the straightener or plate rolls as the case may be. It will then be put on the trucks, taken into the shop and piled on the markers' skids. From here it will be taken to the various cutting machines, and then on to the punches. As it is punched it will be stacked up until required for assembling, when the various pieces are bolted tightly together, taken to the riveters and riveted up. Reamed work will, of course, be reamed before riveting. The work may now be finished up, cleaned and painted, and as soon as the paint is dry it is ready to ship.

A study of Fig. 1 will show that the machines and department are arranged approximately in the order mentioned above, starting at the south end of the plant. Variations from this rule are due to physical limitations, or are the result of experience.

(To be continued.)

NEW STEEL PRODUCTS COMPANY

Several Canadian steel industries are to be merged as the Steel Products of Canada, Limited. The participating firms are the Gananoque Spring and Axle Company, Limited; the D. F. Jones Manufacturing Company, Limited, of Gananoque, and the Dowsley Spring and Axle Company, of Chatham, Ont.

The capitalization of the new company is as follows:—

Six per cent. bonds	$600,000
Preferred stock, 7 per cent.	750,000
Common stock	750,000
	$2,100,000

Seventy-five per cent. of the securities in the new company has been taken in lieu of cash by the holders of stock in the amalgamated companies, and that the rest will shortly be offered to the public for subscription, by Messrs. Richardson and Company, of Montreal.

Mr. W. T. Sampson, for many years manager of the Gananoque Spring and Axle Company, will act as managing director of the new company. His long association with the Jones Company and the Chatham concern, the latter of which was a subsidiary of the Spring and Axle Company, render him particularly well qualified to direct the Steel Products Company, and the future of the consolidation is looked upon as exceedingly bright.

The Gananoque Spring and Axle Company has been engaged in the manufacture of steel springs and axles for upwards of fifty years, while the Jones Company has been in existence for an equally long time, and is among the foremost concerns of the Dominion manufacturing shovels and other steel specialties. The Chatham company is a comparatively recent organization.

RUBBER FROM COKE-OVEN GAS.

A recent issue of the "Bulletin" of the French Society of Civil Engineers contained a paper on "Coke-Oven Gases and Their Utilization," by M. Gouvy, in the course of which he refers to a new application of coke-oven gas, viz., the manufacture of artificial rubber. M. Gouvy points out that after prolonged investigations conducted by various chemists, with the object of finding a substitute for india-rubber, it was produced synthetically by the processes patented by Bayer & Company, of Elberfeld, which were based upon the manufacture of butadeine. More recent researches, however, have shown that rubber consists mainly of a hydrogen carbide, most complex in composition, viz., isoprene, the simplest form of which is butadeine. This having been shown to exist in small quantities in the crude gases of coke ovens, the above-named company based their process upon its polymerization into isoprene, i.e., rubber. The raw material is really extracted from coke ovens by a special treatment of benzol, which distills below 25 deg. C. The manufacture of artificial rubber by this process is still in the experimental stage, and the cost price must be very high, but M. Gouvy thinks it may be reduced.

TIDAL WATERS AS A SOURCE OF POWER.

By C. A. Battiscombe.

At a meeting of the Society of Engineers (Incorporated), held on Monday, May 5th, a paper on "Tidal Waters as a Source of Power" was read by Mr. C. A. Battiscombe, the object of the paper being to draw attention generally to the commercial possibilities of hydro-electric installations in the British Isles, more particularly with regard to the use of the tides. After some introductory remarks in reference to tidal intervals and the range of neap tides, the author points out that in this connection the head of water available for actuating turbines cannot exceed one-third of the range of minimum tides. The form of installation required for a continuous output of power is then discussed, the chief objections to twin installations, so placed that the tidal interval at the one will not synchronize with the tidal interval at the other, being pointed out. An outline is given of the arrangements proposed for the constant maintenance of a working head, by means of a chamber for the turbines, connected by valves to the tidal way and to three reservoirs in which the tidal water may be impounded, and to this is added a description of the proposal of sequence of flow between the tidal way and the reservoirs.

It is claimed that the utilization of the tides for power purposes presents few engineering difficulties as far as principles are concerned, but that the real difficulty lies in the question of cost, and therefore in the choice of the site and in the design of the structural details.

The expenditure on commercial works that an engineer is justified in recommending is suggested, and some explanatory remarks are offered in respect to various items given in the rough estimate and to the principles governing the economical capacity of a proposed installation for any range of tide. The rough estimate follows next and the cost of the Board of Trade unit, obtained from the proposed installation, is then considered from the point of view of supply and demand, both from a commercial and a municipal standpoint, on the basis of annual expenditure over a period of fifty years. The paper concludes by insisting on the importance of regarding the supply of fuel as a matter that concerns the whole nation; that the demand for combustible fuel is continually increasing, and that coal being practically the only fuel found in England, it would be mere folly to neglect any other available source of energy whereby the present rate of consumption of coal may be sensibly reduced. It is submitted that not only can the tides be utilized as a constant source of power, but that, taken in conjunction with the power that could be derived from fresh-water rivers, their utilization would be a great gain to the commercial and industrial interests of the United Kingdom.

MOOSE JAW ELECTRIC RAILWAY COMPANY.

The gross receipts of the Moose Jaw Electric Railway Company amounted to $77,996 for the past year; 1,607,770 passengers were carried. The assets of the Moose Jaw Electric Railway are placed at $573,367, of which $570,128 is in plant, property and equipment, and the balance of $2,239 is in accounts receivable. The liabilities are: capital stock (paid up), $480,271; bills payable, $15,359; accounts payable, $22,581; and a profit and loss surplus of $15,359. The company's officers and directors are: president, Mr. A. A. Dion; vice-president, Mr. Newton J. Kerr; secretary-treasurer, Mr. D. R. Street, and Messrs. E. J. Daly, E. O'Connor, T. Frank Ahearn, P. B. Mellon, A. H. Dion and Charles E. Armstrong.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (7s.)	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 24. TORONTO, CANADA, JUNE 5, 1913. No. 22

CONTENTS OF THIS ISSUE.

FACTORS IN PLANT DESIGN.

As one of the earliest factors of industrial economy, as applied to factory construction and operation, there is no more important phase open for thorough consideration than a complete summary of the many demands which will be made upon the building after erection. A careful routing of work from its raw state until it reaches the siding, both these initial stages being included in the study, means much toward low operating cost throughout the years during which the plant will be in service. Such items as location, market, cost of labor, power, arrangement of buildings and machinery, and future extensions, if given most careful study in the early stages of design, frequently minimize operating expenses to such a degree that if computed over a number of years, would vindicate a thorough initial investigation running into a considerable sum.

In his article dealing with a design of a structural steel plant, Mr. Darling gives adequate attention to this phase of engineering design, and clearly cites the advantages to be derived from ample provision for conditions bearing upon the efficient housing of an industry.

THE MASS CURVE IN DETERMINING STREAM FLOW YIELD.

It is only very recently that the mass curve has been used to determine the yield of a watershed. The maximum quantity of water which can be obtained daily throughout the driest cycle of years covered by the records is exceedingly difficult to obtain if it is attempted to secure the information by numerical means. The mass curve furnishes a ready and convenient method of analyzing the flow of a stream, and it is rather surprising that it has not been more widely used. This curve or diagram is used for computing the yield of a watershed from a continuous series of gaugings, and at the same time for determining the volume of reservoir capacity required to store the flood waters for use in season of drought so as to maintain a specified constant rate of flow. The method was first described by Mr. John R. Freeman in his report on New York's water supply.

Briefly, the method consists in adding up the totals of the daily or monthly yield from month to month for the whole period of gaugings under consideration, then plotting the successive steps of accretion of the mass as an irregular line or mass curve. Any desired rate of draft may then be assumed, and its successive sums plotted to the same scale, and of a uniform rate. This draft curve forms a straight, inclined line, and if it is made to start coincident with some point or summit on the mass curve, the divergence of the two curves at successive points serves to show the volume of storage that would have been required on this date to have maintained the required rate of flow up to that time.

A very interesting paper in which this mass curve method was used extensively is one read recently before the Western Society of Engineers by George L. Thow and L. R. Howson. In this paper the various steps in the computation of yield on the Hickman Creek watershed, run-off records of which are available for a period of twenty-six years, are analyzed. This discussion will well repay careful study by the hydraulic engineer interested in the study of stream flow. The increase in acreage of drained agricultural lands will steadily increase the run-off and continue to lower the level of the ground water. With the exhaustion or full development

of ground water supplies, the impounding of rainfall in reservoirs will be necessary.

One of the most significant conclusions drawn from the above paper is the vital importance to be placed on the length of the run-off record. This is well shown by a few figures from the paper. With an available storage equal to 12 inches on the watershed a daily yield of 3,600,000 gallons per day could be obtained. Let us suppose the record ended with 1902, covering a period of eighteen years from 1885 to 1902, inclusive. During this period the driest cycle of years occurs from 1889 to 1902. Assuming the same amount of reservoir capacity available as above, we find a daily yield of 4,300,000 gallons per day could thus be obtained.

Selecting the period from 1888 to 1898 from the record, we have eleven years during which time, even in the driest years, 1894-95, a daily yield of at least 5,800,000 gallons per day could be obtained, based on 12 inches of storage available.

These facts show very conclusively that by using a record of short duration some very erroneous conclusions as to the least yield might result. The following tabulation, taken from the paper, shows clearly the value of the length of a run-off record in the computation of yield:—

Length of record.	Least yield during driest cycle.	Per cent. based on 26-year record.
Twenty-six years	3.6 M.G.D.	100 %
Eighteen years	4.3 M.G.D.	120 %
Fifteen years	4.5 M.G.D.	125 %
Eleven years	5.8 M.G.D.	160 %

Even with a record with 26 years of run-off data available, it cannot be safely assumed that a drier period has not existed previous to those records, or may not again occur at some future time.

THE INTERNATIONAL JOINT COMMISSION.

In *The Canadian Engineer* for May 1st and 8th we commented editorially upon the Livingstone Channel in the Detroit River, since the opening of which, last October, the town of Amherstburg, Ontario, had raised strong objection to the proposal to construct a dam at Bois Blanc, the purpose of which was to maintain the normal depth of water in the river above the channel. The objection brought forward by Amherstburg was that the proposed dam would divert a large body of water into the narrow channel between the town of Amherstburg and Bois Blanc Island, increasing the current to such an extent as to render the harbor practically useless. It was further predicted that the ice brought down by this increased flow would destroy docks and personal properties along the water front. There was also the danger to health from Detroit City sewage, which would be diverted in proximity to the shore at Amherstburg.

The commission handled most admirably the test consigned to it. In conclusion, it deemed necessary the erection of a dyke for the improvement and safety of navigation, but that such, if built on the west side of the river instead of adjacent to Amherstburg, would reduce the velocity of flow to the desired degree, at the same time not affecting the flow in the Amherstburg channel. Its recommendation to the Governments of both countries was that a dyke be built upon this location; and further, that considerable excavation work be executed on the west side of the Livingstone Channel, and that the shoals on the east side be also dredged.

A SEWER DISCHARGE DIAGRAM.

By J. M. M. Greig, A.M.I.C.E.*

[Thinking that many of our readers who are interested in sewer design and construction might care for an extra copy of the diagram accompanying this article, we have had a few extra copies struck off on coated stock, on the back of which is given the formula to be used in connection with it. Engineers who would care to receive a copy of this diagram may do so by asking for it—*Editor.*]

The author compiled the accompanying diagram to assist in arriving at the best form of sewer for each particular case, or rather to give a choice of several sizes of sewers with equal discharging capacities.

The diagram is arranged to show the discharge in cubic feet per second of circular brick sewers, egg shaped brick sewers, concrete culvert shaped sewers of the type illustrated, and vitrified pipes when running full at any gradient. It also gives an indication of the velocity of flow in the concrete culvert types, but these velocity curves do not hold for the brick sewers.

The formula used was:—

Discharge in cu. ft. sec.—$A\ C\ \sqrt{R}\ \sqrt{S}$

Where A = Sectional area.

C = Kutter's coefficient for different values of $\sqrt{R}$ and N (taken from Wollheim's sewerage note book).

R = Area divided by wetted perimeter.

S = Slope.

N = Coefficient of friction—.015 for brickwork and .013 for concrete.

The value $AC\ \sqrt{R}\ \sqrt{S}$ was obtained for each cross section of sewer for a gradient of 1. in 100 and having got together these amounts the diagram was constructed as follows:—

The slopes whose square roots equalled 0.001, 0.002, etc., up to 0.1 were marked down at equal distances along a horizontal line from the origin towards the right and a vertical line was erected at 0.1, that is, at the 1 in 100 slope. On this vertical line a scale of discharges was marked off. Then the value of $AC\ \sqrt{R}\ \sqrt{S}$ previously obtained for each particular size of sewer was noted on the discharge scale and lines were drawn from the origin through these points and on these lines produced the dimensions of these sewers were written above a short length of line. The radial lines drawn on the diagram are through every 50 cub. ft. sec. at 1 in 100 and are merely guides to the eye but by fixing a thread to the origin a convenient straight edge is formed which can be used in finding the following:—

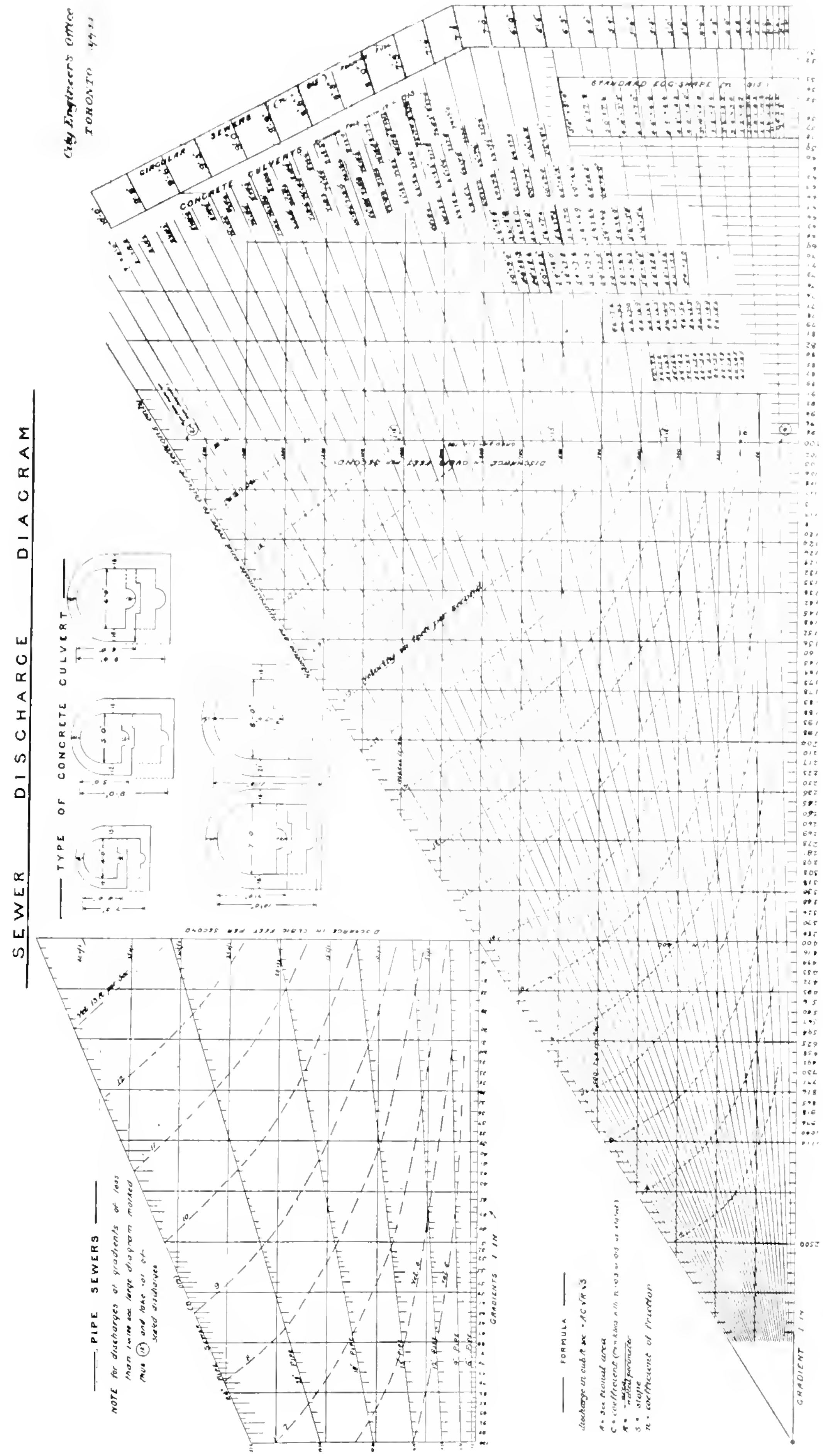
The various sizes of sewers which will give the required discharge at a certain gradient, the discharge any sewer gives at any gradient, or the gradient required to give a certain discharge with a particular size.

If size is required stretch the thread over the intersection of the gradient and discharge lines and the dimensions can be read above the thread on the right of the diagram as, for instance, at 1 in 400, 300 c.f.s. may be got through concrete culvert of 5′ 6″ x 8′ 9″ or 6′ 6″ x 7′ 3″ or a 7′ 3″ diameter brick sewer.

If discharge is required stretch the thread along the line of the particular size of sewer chosen and read the discharge where the thread cuts the gradient line.

If gradient is wanted stretch the thread along the line of the sewer and read off gradient where the thread cuts the discharge line. The discharge scale on the larger diagram for the pipe sewers shown thus: (12) is 100 times that for the larger sewers, that is the figure 1,000 on the 1 in 100 line for an 18″ diameter pipe must be reduced to 10. c.f.s.

*City Engineer's Department, Toronto.


SEWER DISCHARGE DIAGRAM
TYPE OF CONCRETE CULVERT
City Engineer's Office
TORONTO
CIRCULAR SEWERS
CONCRETE CULVERTS
STANDARD EGG SHAPE
PIPE SEWERS
FORMULA
GRADIENTS 1 IN
GRADIENT 1 IN

CONCRETE CULVERTS.

By F. H. McKechnie, B.A.Sc.

Introduction.—The distinction between bridges and culverts is not a hard and fast one, although Webb, in his book on railroad construction, attempts to define the term "culvert" as follows: "The term culvert may be applied to all water channels passing through railroad or highway embankments, which are not of sufficient magnitude to require a special structural design, such as is necessary for a large masonry arch or truss bridge." This seems to be rather a mistaken idea of culverts which is much too frequently met with, that, given a standard design or two for culverts, all that is necessary is to choose which design to use and put the culvert in place. Such a method of choosing the culvert should only be used where all the conditions for the foundations are perfect, such as rock bottom, in which case perfect stability of foundation is assured.

There are a number of things it is important to consider before deciding ou size, style or shape of culvert to be used.

Waterway Area.—Where no reliable data in reference to the volume of water flowing through a culvert opening is obtainable, the culvert area may be computed approximately by a number of empirical formulae. Among these is Myer's formula, which is as follows: The required culvert area is equal to the square root of the drainage area in acres, multiplied by F, where F is a coefficient varying from unity, for flat country, to four, for rolling or mountainous country from which rainfall is discharged at a greater velocity. The proper value for the coefficient, for any particular location, must be selected entirely by the judgment of the engineer.

Talbot's formula is another in common use: Area of waterway in square feet is equal to C, a constant, into the fourth root of (the drainage area in acres)^3 cubed. For steep and rocky ground C varies from two-thirds to one. "For rolling agricultural country, subject to floods, and with the length of the valley three or four times its width, C is about one-third. In other districts, not affected by accumulated snow, and where the length of valley is several times the width, one-fifth, one-sixth, or even less may be used."

Formulae such as these two given depend very largely upon the choice of coefficient so that they are valuable, chiefly as a guide to the judgment, rather than hard and fast rules to be followed. They indicate a probable maximum and minimum between which the true result may lie.

On the legal side of the subject Engineering Record says in part: Although courts have ruled that the railway companies are not to be held liable for insufficient capacity for extraordinary floods, there is too much guess work in determining sizes of such openings. It is easy to establish better procedure for selecting the cross sections of culverts than exist in some railways. The main factor is the shape of the drainage area and another, quite as important, is the topography, also the effect on the flow of the character of the soil. This factor rarely receives the attention it should. A naturally impervious soil is rendered practically impervious by a rainfall of half an hour and so will yield a much larger run-off toward the end of a heavy storm than one that is very sandy. A very wet marsh will also yield an extraordinary run-off in a heavy storm. There are good formulae, but one suitable for prairie is not suitable for hilly country. While a railway may be exempt from damages, due to extraordinary freshets, the courts will hold it strictly to account where the channels are inadequate to carry off the water that may be reasonably expected.

The following decision was given in the case of the Southwestern Railway versus McKay, for injury to property on account of flooding: "It is the duty of a railroad company to provide proper and sufficient openings or culverts for the escape of water of all streams crossing its roadbed, so as not to flood the land of other riparian owners, whether at ordinary stage of the water, or during floods which could reasonably have been guarded against, and if it fails to provide such openings it is liable to any person damaged thereby."

Where there is no previous knowledge of the country and there are no records which could be of assistance in determining the flow, one of the safest plans is to build a temporary trestle, which will not only provide an ample waterway for all floods during its life, but which will permit of the construction of a culvert of proper dimensions under the trestle with the least possible interference with the construction of the culvert. The life of such a trestle would be sufficient to determine the area required closely enough.

Placing the Culvert.—In building a culvert it is not always necessary to place it in the old stream bed, in fact it is often very wise to choose an entirely new spot for the stream and culvert. The culvert should be placed in such a position that the water will come to it as directly as possible, and will have the best possible channel away from it. For this purpose the stream may be diverted and cleaned out above and below the culvert opening, giving all the advantage for the culvert of a clear entrance and exit for the water.

Except where such a condition is impossible of realization, a culvert should be placed at right angles to the centre line of track, on account of the great saving in the quantity of the material used, the improvement in its appearance and from the fact that in the skew culvert new stresses may arise on account of the different position of the structure with respect to the embankment.

Foundation Bed and Foundations.—Careful soundings should be taken before locating the culvert and the result of the soundings should, in a large measure, determine the character of the culvert to be used, whether plain or reinforced. Patton says, in his treatise on foundations: "When structures fail, it may in general be said, that it is impossible to determine the cause, but in a large majority of cases, it can be traced to that part of the structure under ground or under water, and ultimately due to the failure of the foundation bed. For even if the part of the structure under ground is defective in some of its parts, it throws an excessive weight on some part of the foundation bed. Be sure of your foundation bed and foundation and except in extreme cases the upper part of the structure will take care of itself."

It is usually perfectly safe to build any culvert required on material which can be called rock. Boulders or gravel or hard pan can also be called reliable for ordinary structures under good conditions. The scouring action of water should be avoided in all cases. Confined sand is safe to bear a load of any amount as long as it is confined and running water is kept away from it. Taken in general though, sand is not a very satisfactory foundation. Compact and dry clay will carry very large loads, but it is very soon rendered useless by contact with water, as it is then a pasty material and gives away by flowing and bulging up around the structure.

Trautwine says, that on good compact gravel sand or loam, at a depth below atmospheric influences, two to three tons per square foot are safe. Pure clay, especially if damp, should not be trusted with more than one to two and a half tons, according to the case. Examples will be given, in a later part of this paper, showing effect of different conditions of foundations, on actual culverts in the field.

Typical Specifications for Concrete Structures.—From Ontario Government Highway Report, 1911:

(1) The general type of highway bridge shall preferably be as follows, but limiting lengths are not absolute and may be varied as occasion permits.

(a A concrete arch, or concrete abutments with slab covering for spans up to sixteen feet.

(b) A concrete arch or concrete beam bridge for spans sixteen to forty feet.

(c) A concrete arch for spans exceeding forty feet in length.

(d) All concrete structures will preferably be reinforced, using medium steel.

(2) All parts of the concrete shall be proportioned so as not to exceed the following unit stresses, in pounds per square inch for stone or gravel concrete:

Extreme fibres of beams and slabs, for bending......	650
Shearing stress in concrete	60
Bond between plain steel and concrete	60
Bond between deformed steel and concrete	100
Tension in soft steel	14,000
Tension in medium steel	16,000
High steel, one-half the elastic limit, but not exceeding	20,000

(3) Reinforced concrete beams and slabs will be designed on the assumption that compressive stresses may vary directly as the distance from the neutral axis. No allowance will be made for concrete in tension. Ratio of moduli of elasticity of steel and concrete will be assumed as fifteen. All calculations will be based on concrete having a crushing strength of two thousand pounds per square inch in twenty-eight days.

(4) The bearing power of soils under foundations shall, if possible, be based on actual test, but where this is impracticable, the following shall be used:

	Tons per sq. ft.
Rock in thick beds	25
Strong gravel and coarse sand, dry	8
Compact sand or firm clay, dry	4
Clay, moderately dry	2
Clean, dry sand, not cemented	2
Wet clay	1
Quicksand and wet, yielding soils	0 to ½

(5) The safe bearing power of wooden piling, determined by the following: $P = \dfrac{62wh}{s-1}$

Where P = Safe load in pounds.
W = Weight of hammer in pounds.
H = Fall of hammer, in feet.
S = Penetration of last blow, in inches.

(6) Each structure shall be designed to carry the following loads:

(a) A dead load consisting of the total weight of concrete steel and other material therein, including the weight of earth or other superimposed filling; the weight of the concrete to be assumed at one hundred and fifty pounds per cubic foot, and earth fill at one hundred pounds per cubic foot.

(b) A uniform load, expressed in pounds per square foot of floor surface, covering the whole or any part of the bridge.

(c) A concentrated live load expressed in tons, passing over any portion of the bridge, on two axles at ten-foot centres and six-foot gauge, two thirds of the load to be carried on the rear axles.

(d) For floor slabs, a concentrated load expressed in pounds midway between stringers or beams and resting on a base one foot wide.

Materials.—Cement must be of a known brand of Portland cement, approved by the engineer in charge of the work, and complying with the requirements and tests of the Canadian Society of Civil Engineers, for cement.

Fine aggregate shall consist of sand, crushed gravel or stone screenings, passing when dry a screen of one-quarter inch mesh; and not more than six per cent. passing, when dry, a screen having one hundred meshes to the linear inch. The material shall be clean, sharp, siliceous and of varying sized grain. Gravel, if used in its natural state in making "fine" concrete, shall be of uniform character and varying grain, making a dense and compact mass, such that the smaller particles will fill the voids between the larger, the largest stones therein to be such as will flow readily around the reinforcement but will not separate from the mortar in laying. Gravel shall be free from earthy mould or organic matter. Should there be insufficient fine material to properly fill the voids and make a compact mass, the deficiency shall be corrected by the addition and mixing of such quantity of sand, and in such manner as may be required by the engineer or inspector in charge of the work. Should the gravel to be used contain an excessive amount of sand, loam, large stones or other objectionable material, it shall be screened through a mesh of proper size. Where the sand and fine stuff is thus removed the resulting mass of pebbles shall be treated as broken stone and sand shall be mixed therewith in the manner herein described for broken stone concrete. Where large stones only are removed the material shall be treated in the ordinary manner for gravel concrete.

The steel used for reinforcement shall have an ultimate strength of not less than fifty-five thousand pounds per square inch and must bend cold one hundred and eighty degrees to a diameter of the thickness of the piece tested, without fracture.

The water used is to be clean, and the mixture must be wet enough to flow into the forms and around the reinforcement without permitting the separation of the coarser aggregates from the mixture in conveying from the mixer to the forms. The weight of Portland cement shall be assumed to be one hundred pounds per cubic foot.

Proportioning Materials.—The proportions of materials to be used in mixing fine concrete shall be by measure, loose and unless otherwise directed by the engineer, shall be as follows:—

Gravel Concrete.

(a) Abutments, piers and wing walls: One part of cement to seven parts of gravel.

(b) Arches from the springing line, floor slabs, beams and parapet walls: One part of cement to five parts of gravel.

Broken Stone Concrete.

(c) Abutments, piers and wing walls: One part of cement, three parts of sand, and six parts of broken stone.

(d) Arches from springing line, floor slabs, beams, and parapet walls: One part of cement, two parts of sand and four parts of broken stone.

The specifications given above, while incomplete, cover pretty well the usual specifications required in the building of concrete culverts.

Types of Concrete Culverts in Common Use.

Concrete pipe culverts—plain and reinforced.
Old rail culverts.
I-beam culverts, and box culverts.
Arch culverts—plain and reinforced.

These types of culverts will be discussed in the following pages, with examples of each.

Concrete Pipe Culverts.—Tests of plain and reinforced culvert pipes.*

The tests were intended to throw light on the strength of pipes placed in railroad embankments, and are valuable on account of the practical conditions under which the tests were carried on. The main tests were made with a specially prepared testing apparatus, which included a box of strong, stiff construction, and the pipes were embedded in sand and the load applied through a saddle, resting on a sand cushion. Short rings of concrete and reinforced concrete were tested, both under concentrated load and under distributed load.

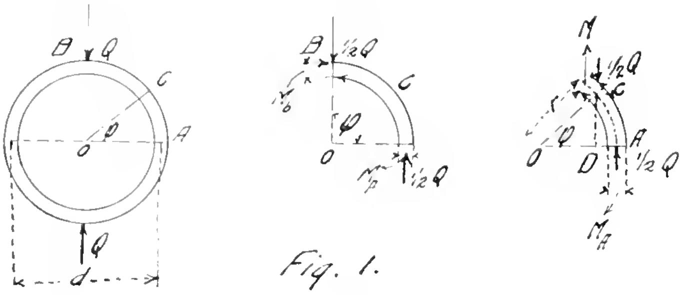


Fig. 1. (a) (b). (c)

Mechanics of pipes and rings subject to external pressure.

Bending moments and conditions of loading: The stresses developed in rings subject to external earth pressure, as in railroad culvert pipes, are dependent upon the bending moments developed, and, as the exact load coming upon the ring and its distribution over the surface are difficult to determine, the bending moment is in general quite uncertain. The amount of the load and its distribution, and therefore the bending moments on different parts of the ring, depend upon a number of conditions, some of them being: the nature of the earth used in filling; the method of bedding the pipe; the way of tamping the earth at the sides; the amount of the lateral restraint or pressure of the earth horizontally; the method of filling and tamping the earth above; the condition of moisture in the earth, etc.

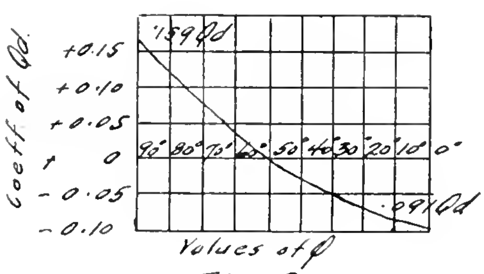
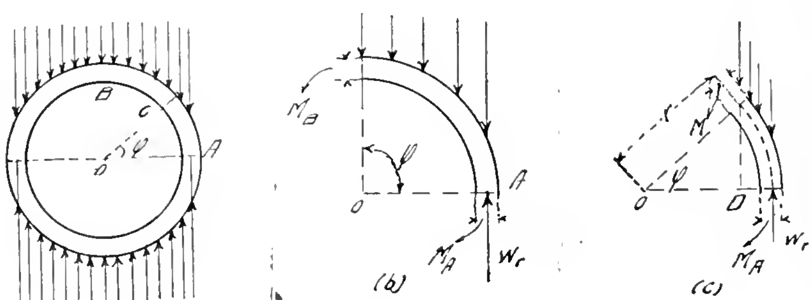


Fig. 2.



(a) (b) (c) Fig. 3.

Evidentally in such earth as quicksand, the conditions may approach those of external hydrostatic pressure, and on the other hand, in the deep sewer trenches the earth filling may act so that its weight is carried against the sides of the trench. In discussing the stresses in rings, it is well, first, to find the bending moment for certain assumed conditions of loading, then to make tests under varying conditions of loading, and finally to compare these results with a view to determining the probable range of bending moments under the actual conditions of construction. The assumed loadings include:—

(1) A concentrated load at the crown of the ring.

(2) A vertical load distributed uniformly over the horizontal section.

(3) A distributed vertical load together with a horizontal load, distributed perpendicularly over the sides of the ring.

(4) An oblique loading.

On account of the uncertainty in these calculations, the difference of the intensity of the load at the crown and at the extremities of the horizontal diameter, due to the different depths of earth, need not be considered. In general, the pressures on the lower half of the ring will be considered to be the same as on the upper half. As refinements are not essential, and approximations are permissible, the equations will be based on a thin ring of homogeneous material, having a constant modulus of elasticity, and it will also be assumed that the changes from a circular form have little effect on the dimensions of the ring.

For a load concentrated as shown in Fig. 1 a, the quadrant shown in Fig. 1 b will be in equilibrium under the load ½Q at B, a thrust ½Q at A, a moment 0.091Wd at A, and a moment 0.159Wd at B.

At B, M is 0.159Wd. (1)

For a point C at an angle ϕ above the horizontal diameter (Fig. 1 c) the equation for the bending moment is $M = Qd\,(0.159 - \frac{1}{2}\cos\phi)$ (2)

Fig. 2 shows the changes in bending moment between the haunches and the crown. The point of zero bending moment is $\phi = 50^\circ\ 30'$. At this point the sign of the bending moment changes from negative to positive.

The expression for the deflection of the pipe under concentrated load or for the change in vertical diameter is $\frac{0.0186Qd^3}{EI}$ and for the change in horizontal diameter is $\frac{0.171Qd^3}{EI}$.

Distributed Vertical Load.—For a vertical load, distributed uniformly over the horizontal section, as shown in Fig. 3 a, the quadrant shown in Fig. 3 b will be in equilibrium under the load, a thrust at A, a moment at A, and a moment at B.

Calling the load on the ring W, and the mean diameter of the ring d, the moments at A and B, which are equal, are given by the expression $M = 1/16Wd$. (3)

For a point C at an angle ϕ above the horizontal diameter (Fig. 3 c) the equation for the bending moment is $M = 1/16Wd\,(1-2\cos^2\phi)$ (4)

In Fig. 4 is shown the change in bending moment between the haunches and the crown. The point of zero bending is ϕ—45°. At this point the sign of the bending moment changes from negative to positive.

* Tests of cast iron and reinforced concrete culvert pipe, by A. N. Talbot, in University of Illinois Bulletin.

The expression for the deflection of the pipe, or for the change in vertical diameter, is $\frac{1/96Wd^3}{EI}$, and the change in horizontal diameter is the same.

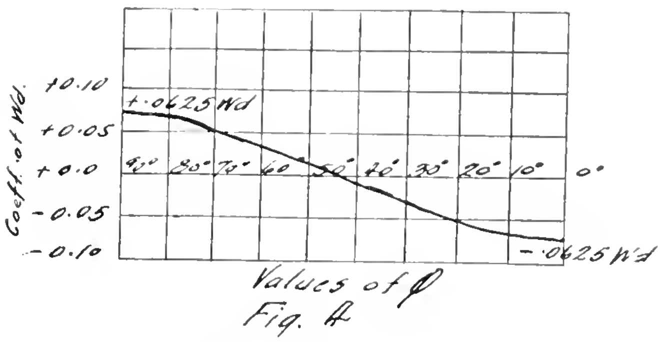


Fig. 4.

Distributed Vertical and Horizontal Load.—If it be considered that the vertical load is uniformly distributed over the horizontal section of the pipe as before, and that there is also a horizontal pressure uniformly distributed against the pipe, the loading will be as represented in Fig. 5 a.

If the ratio of the horizontal pressure to the vertical pressure is denoted by q, the moments at A and B will be given by the equation, $M = 1/16(1-q)Wd$ (5)

For a point C at an angle ϕ above the horizontal diameter (Fig. 5 b) the equation for the equation for the bending moment is $M = 1/16Wd(1+q-2\cos^2\phi-2q\sin^2\phi)$ (6)

The bending moment becomes zero at $\phi = 45°$, as in the other case. If the intensity of the horizontal pressure is the same as that of the vertical pressure, q = 1 and M becomes zero at all points. This corresponds to uniform external pressure, and equal pressure is produced in all parts of the ring.

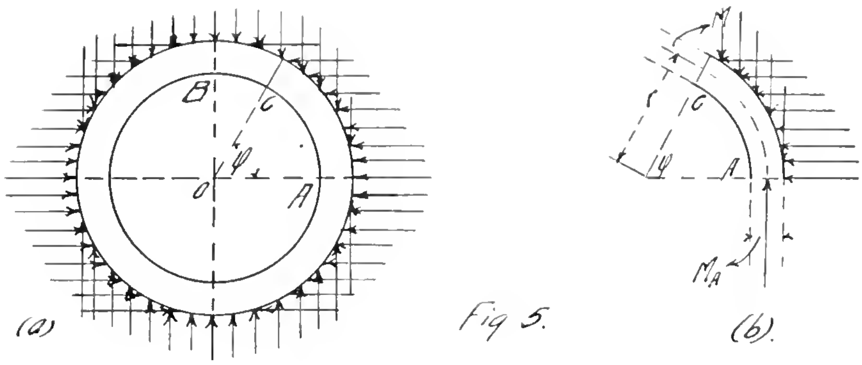


Fig 5.

Oblique Load.—In the case of the concentrated load and the distributed load it is seen that the bending moments at A and B are large, and that the moment decreases to zero amount at some point between A and B. If it was certain that this loading was present, no provision against bending need be made at the points of zero bending moment, and but little for points close on either side. However, it must be borne in mind that if there is a change from the specified loading, the conditions of the bending moment are likewise changed. If, for example, the method of filling over the pipe should be such as to make the pressure come obliquely, as

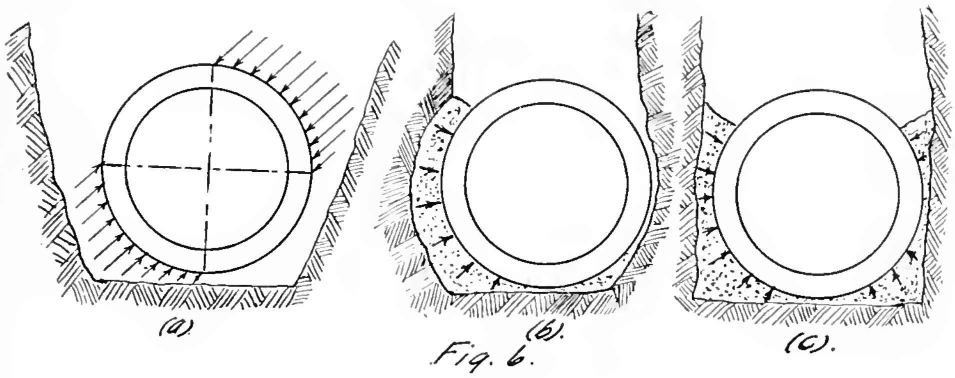


Fig. 6.

shown in Fig. 6 a, the maximum moment would be at the 45° points and the maximum moments at the ends of the horizontal and vertical diameters.

Similarly, if in a trench a slip of earth cau[se] the pressure to come against the pipe, as shown in Fig. 6 b, the the distribution and amount of the bending moment would be very different from that of the usual vertical loading. While an accurate measurement of the bending moments in such cases is impossible, yet in any case it is possible to judge the amount and location of the bending moments, within reasonable limits, and to provide strength in the section of the pipe to take the consequent stresses.

Resisting Moments and Stresses.—With rings whose thickness is small in comparison with the diameter, the difference between the length of the inner and outer fibre is small, and the expression for the resisting moment used for ordinary straight beams may be applied without much error. The length of ring (width of beam) will be considered unity. Call t the thickness of the ring.

For the rectanglar section of the ring the resisting moment will then be $1/6ft^2$ where f is the unit stress at the remotest fibre. In sections where there is no thrust, the maximum stress at the remotest fibre may be found by equating the expression for bending moment and the expression for the resulting moment and substituting the numerical values at the section considered. If a thrust exists at the given section, this thrust may be considered to be uniformly distributed over the section and the stress will be equal to the sum or difference of the resisting moment stress and the thrust stress.

For a concentrated load at the crown (Fig. 1) the stress at B, since there is no thrust, may be determined from the formula $\frac{1}{6}ft^2 = 0.159Qd$ (7)

At A, the same form of expression may be used for the resisting moment, but this must be combined with the stress due to the vertical thrust. Considering this to be uniformly distributed, the stress in the remotest fibres will be

$$F = \frac{Q}{t} + \text{ or } - \frac{0.091}{\frac{1}{6}t^2} \quad (8)$$

The minus sign will be used for the outer fibre and the plus sign for the inner fibre. At any point C (Fig. 1 c) the stress at the remotest fibre may be shown to be

$$f = \frac{\frac{1}{2}Q\cos\phi}{t} + \text{ or } - \frac{M}{\frac{1}{6}t^2} \quad (9)$$

For a uniformly distributed horizontal load the stress at the crown B will be $f = \frac{1/16\ Wd}{\frac{1}{6}t^2}$ (10)

and at A, $f = \frac{1}{2} + \text{ or } - \frac{\frac{3}{8}Wd}{t^2}$ (11)

and at any point C, (Fig. 3 c) $f = \dfrac{Wr\cos^2\phi}{t} + \dfrac{M}{\frac{1}{6}t^2}$ (12)

For a distributed vertical and horizontal load (Fig. 5) there will be a thrust both at A and B. The stresses at the crown B, will be given by the equation

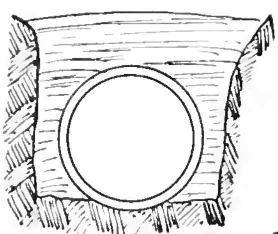
$$f = \frac{QW}{t} + \text{ or } - \frac{MB}{\frac{1}{6}t^2} \qquad (13)$$

At A, the extremity of the horizontal diameter

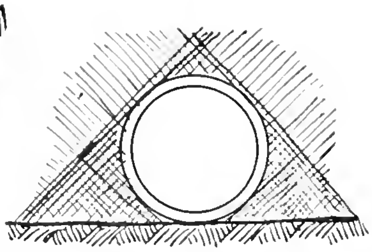
$$f = \frac{W}{t} + \text{ or } - \frac{MA}{\frac{1}{6}t^2} \qquad (14)$$

At any point C, (Fig. 5 b) the expression for the stresses may be written $f - = \dfrac{W\cos^2\phi}{t} - \dfrac{qW\sin^2\phi}{t} + \text{ or } - \dfrac{M}{\frac{1}{2}t^2}$ (15)

These formulae may be applied without any great error to plain concrete rings at the breaking loads, if the modulus of the materials for rupture, obtained under the same conditions of thickness and loading, be substituted for the maximum tensile stress f. For a reinforced concrete ring the conditions are somewhat different from the above. For ordinary cases the bending moment, determined as above, and the resisting moment of the reinforced concrete section may be equated.



8(a).



8(b).

The amount of the tension in the steel at the point A, may be calculated by the formula $f^1 = \dfrac{f - \frac{1}{2}nT}{t(1+np)}$ (16)

The formula is applicable for both concentrated and distributed loads. In this formula f is the tensile stress in the steel due to the bending moment, p is the ratio of the area of reinforcement for a unit width of beam to the distance between the centre of the steel and the compression face of the concrete. T is the thrust or pressure against the face of the section, and n is the ratio of the moduli of elasticity of steel and concrete, and equal to fifteen for the experiment. t is the distance from the compression face to the centre of the steel reinforcement.

In the actual tests on pipes the following results were obtained:—

Concentrated load tests: The plain concrete rings broke before there was an appreciable deflection, so no measurements of deflections were made.

The reinforced rings deflected considerably before final failure. At a load of from 1,000 to 2,000 pounds per linear foot fine cracks appeared on the tension face, generally the top or bottom. When higher loads were applied, numerous cracks appeared on the tension faces at the top, bottom, and sides. Two forms of critical failure were seen; one a tension failure of the reinforcing bar at the top or bottom of the ring, and the other a failure of the concrete by the stripping of the concrete from the tension face.

Distributed load tests of reinforced concrete rings: In the reinforced concrete rings cracks appeared early in the test on the tension side at the top and bottom, but the load continued to increase to a load of 15,000 pounds per linear foot. The reinforced concrete rings were much stiffer than the plain concrete rings.

Distributed load tests of plain concrete rings: The plain concrete rings, tested under a distributed load, cracked at the top, bottom and sides at an early load. Later when sufficient side restraint developed the load increased until a considerable difference was shown in the horizontal and vertical diameters.

The critical strength of reinforced concrete culvert pipe where the reinforcement does not exceed, say, 0.75 of 1 per cent., and is of medium steel, may be measured by the resisting moment calculated by the ordinary beam formula. The resistance against diagonal tension and stripping of the concrete over the bars, may be improved by flattening the arc around the top and bottom.

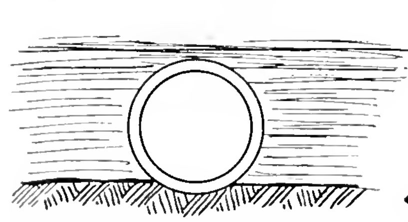
Bedding and loading of pipes: If the layer of earth immediately under the pipe is hard or uneven, or if the bedding of the pipe at either side is soft material or not well tamped, the main bearing of the pipe may be along an element at the bottom and the result is in effect, concentrated loading. This condition may be aggravated in the case of a pipe with a stiff hub or a bell where settlement may bring an unusual proportion of the bearing at the bell and the distribution of the pressure be far from the assumed condition.

In case the pipe is bedded in loose material the effect of settlement will be to compress the earth immediately beneath the bottom of the pipe more completely than will be the effect at one side, with the result that the pressure will not be uniformly distributed horizontally.

In case a culvert pipe is laid in an ordinary embankment by cutting down the sides slopingly, as shown in Fig. 8 a, it is evident that the load which comes upon the pipe will be materially less than the earth weight immediately above it.

In a case where a culvert pipe replaces a trestle and the filling is allowed to run down the slope, as shown in Fig. 8 b, the direction and amount of the pressure against the pipe will differ considerably from that which obtains in a trench or in a case of level filling, shown in Fig. 8 c.

It is possible in this case that the smaller amount of settlement of the earth directly over the culvert pipe, due to the greater depth of earth on adjacent sections, may allow a greater proportion of the load to rest on the culvert pipe than



8 (c).

would ordinarily be assumed. It should be noticed that the distribution of the pressure by means of earth under and over a ring assumes that the earth is compressed in somewhat the same way as when other material of construction is given compression. Unless the earth has elasticity, the distribution of pressure cannot occur. To secure the uniform distribution assumed, the ring itself must give enough to allow for the movement of the earth which takes place under pressure. This is especially true with reference to the presence and utilization of lateral restraint, and a ring which does not give laterally, as for example, a plain concrete ring will not develop lateral pressure in the adjoining earth under ordinary conditions of moisture and filling, to any great ex-

tent. As the conditions of earth and moisture produce mobility and approach hydrostatic conditions, the necessity for this elasticity and movement do not exist, but here the lateral pressure approaches the vertical pressure in amount and the bending moments become relatively smaller.

The importance of care in bedding culvert pipes is shown and also the necessity for care in filling over them and there is also great difference of bending moment developed with different conditions of bedding and filling. Where strength is needed, time will be well spent in taking care in the bedding of the pipe and filling around and over it. A little additional labor will add considerable stability, life, strength and safety to such structures, far out of proportion to the added cost. It is also possible that under careful conditions of laying, lighter structures may be used with a saving in the cost of construction

Concrete culvert pipe in use on the Chicago and Illinois Western Railway: The pipes were built for use in low embankments where the top would be eighteen inches below the bottom of the ties and give satisfaction under heavy freight traffic.

The pipes were made in the shape of hollow cylinders with square ends, and they were four feet in length. They were molded with an interior of four feet with six-inch shells giving an outside diameter of five feet. The pipes were laid end to end in trenches cut as near to the shape of the pipes as possible and were covered with earth thoroughly tamped around the top and sides.

The concrete used in manufacturing these pipes was composed of American Portland cement, limestone screenings and crushed limestone that has passed through a ¾ inch diameter screen after everything that would pass through a ½ inch screen had been removed. The concrete was mixed in the proportions of one part cement to three and a half parts each of screenings and crushed stone. All except form work was done by common laborers. The pipes were left in the forms till the morning of the day after molding, the average time being sixteen hours.

(To be continued.)

ACCIDENTS IN AMERICAN COLLIERIES.

The United States Bureau of Mines has compiled statistics which show that during the calendar year 1912, 2,360 men were killed in and about the coal mines of the United States. Based on an output of 550,000,000 tons of coal produced by 750,000 men, the death-rate per 1,000 employed was 3.15 and the number of men killed for every 1,000,000 tons of coal mined was 4.29. The number of men killed was the least since 1900, the death-rate per 1,000 employed was the smallest since 1899, the death-rate per 1,000,000 tons of coal mined was tbe lowest, and the number of tons of coal produced in proportion to the number of men killed was the greatest on record. The following are the figures for the past few years:—

	Number Killed.			
Years.	Total.	Per 1,000 employed.	Per 1,000,000 short tons mined.	Production per death, short tons.
1907..........	3,197	4.88	6.93	144,000
1908..........	2,449	3.64	6.05	165,000
1909..........	2,668	4.00	5.79	173,000
1910..........	2,840	3.92	5.66	177,000
1911..........	2,719	3.73	5.48	183,000
1912..........	2,360	3.15	4.29	233,000

SEWAGE DISPOSAL BY DILUTION.

By Horace S. Griswold.*

The general principles of sewage disposal and informa-tion as to the various methods used have been discussed in *The Canadian Engineer* several times over, but the following extracts from a paper by Horace S. Griswold, of the University of California, on "Sewage Disposal by Dilution" with special reference to inland streams, will no doubt be of interest to all readers connected with work of that character. The general outline followed comprises seven heads:

1. Sources and Composition of Sewage.
2. Decomposition of Sewage.
3. Present Status of Sewage Disposal.
4. Sewage Disposal by Dilution.
5. Clarification of Sewage by Screening.
6. Sewage Effluent and the Diluting Stream.
7. Conclusions Based on California Conditions.

He goes on to say:—

Sewage is the used water supply of a community; composed ordinarily of the drainage from sinks, the discharge from water closets and baths of botels, apartments and residences; the wastes from bakeries, laundries, stables, saloons, butcher shops; together with rain water from roofs and washings from streets. In general appearance sewage resembles soapy, dirty, wash-bowl water, but with the addition of various floating matters such as pieces of paper, rags, matches, bits of vegetables, fecal matters and other waste materials.

The refuse from slaughter houses, discharges from hospitals and sanitariums, the wastes from breweries, tanneries or canning establishments may be added to the residential wastes. Sewage, then, contains all excreta of human life and excreta of industrial life of various forms.

In spite of the variety of objectionable materials of different sorts conveyed by water carriage, fresh sewage is comparatively inoffensive to sight and has only a slight odor. This is due to the extreme dilution in which these matters are carried. According to Messrs. Kinnicutt, Winslow and Pratt, the sewage from an average residential American city will contain only from two hundred to eight hundred parts of solid matters out of one million parts of sewage (0.2 to 0.8 of a gram per litre), or less than one-tenth of one per cent. This solid matter is half mineral and half organic, with about seventy five per cent. of the mineral and sixty per cent. of the animal and vegetable matters in solution.

Residential sewage is influenced in its character by the relative content of the bodily wastes. The character and composition of the bodily wastes depends upon the type of food the body is receiving as its fuel.

The body uses as its material for developing energy and repairing wastes a rather restricted list of substances known as food stuffs. These ordinarily include:

1 Water,
2 Inorganic salts,
3 Proteids and albuminoids,
4 Carbohydrates,
5 Fats.

Water and the inorganic salts are of no particular significance in the present discussion.

The proteid and albuminoid bodies, found in such foods as meats, cheese, eggs, gelatin, containing C, O, H and N as the basic elements, are extremely complex in character, but are rather readily broken down into simpler compounds.

* Instructor in Civil Engineering, University of California.

The carbohydrates are familiar in every day life in the various starches and sugars, and are relatively simple in structure. The fats, butter as an example, are among the less complex organic compounds, but are more stable, relatively, than either the nitrogenous or the carbohydrate group.

These substances are taken into the body, utilized by it through the processes of digestion and nutrition; and the waste products are given off in the sweat, the breath, the sputum, the urine and in the feces.

The feces are of importance as one of the main constituents of sewage and are composed primarily of:

1. Various indigestible materials, ligaments of meat and cellulose from vegetables.
2. Portions of various undigested materials, fragments of meats, fats, vegetables.
3. Certain products of intestinal secretions.
4. Products of intestinal bacterial decomposition.
5. Inorganic salts of various sorts.
6. Bacteria, harmless or pathogenic, in vast numbers.

The bacterial content per day in the feces of the normal adult has been determined as about thirty million million, and constitutes some thirty per cent. of the total weight in the dry solid matter of the feces.

When it is remembered that typhoid and dysentery are all too common; that the bowel discharges of a person suffering from these or other intestinal diseases may contain the specific germ in vast numbers, then the danger of sewage to the health of the community begins to be manifest.

Sewage, after being deposited in a sewer, does not long remain in its original condition; natural processes occur which completely transform its character. The process of change is commonly spoken of as decomposition.

2. Decomposition of Sewage.—In what follows, the term fermentation will be defined as "the action of micro-organisms upon carbohydrates." The term putrefaction will be defined as "the action of micro-organisms upon nitrogenous substances," i.e., proteids and albuminoids. Both fermentation and putrefaction are brought about by enzyme action. Decomposition will be defined as "the action of micro-organisms upon organic substances." Thus decomposition may mean fermentative action, or putrefactive action or both.

After many years of observation and study, it has been determined that the animal and vegetable constituents of sewage decompose from their original complex, unstable, organic form to a simple mineralized form. The final mineralized form closely resembles ordinary humus in appearance and composition. The change from the complex to the simple is brought about by a process of fermentation and putrefaction occurring in two related phases. The first phase is accomplished by the enzyme action of those sewage bacteria that live and multiply without air. The second phase is affected by sewage bacteria requiring oxygen. The two phases are not entirely separate and distinct; under certain conditions it is possible to have both anaerobic and aerobic decomposition occurring simultaneously.

The process of decomposition consists of the hydrolyzing and liquifaction of some of the simple compounds; a breaking down in structure of the more complex ones to those of less complexity, and finally, the complete oxidation and nitrification of these relatively simple substances. Gases of a more or less objectionable character, CO_2, CH_4, H, N, NH_3, H_2S, are liable to be among the products of these decomposition steps.

3. Present Status of Sewage Disposal.—Since the very earliest times it has been the effort of man to rid himself of the waste products of his life with the least trouble and danger. The method has progressed and developed from its original simple personal state, through the various processes of disposal by means of trench, midden heap, privy and dry earth closet, to the present almost universal system of water carriage. This system is used by the community, for the benefit of the community and is under community control. The water conveying and disposal of the wastes of life has been found so convenient and simple that for years, with no thought of danger, communities discharged their crude sewage into the nearest watercourse. Conditions of positive physical nuisance, brought about by an overloading of the streams, finally forced a restriction on and a governing of the method.

For many years the opinion was held that sewage, in almost any quantity, might be safely placed in a stream, as the flowing water would purify itself. To-day, however, it is known that flowing water is dangerous in so far as it rapidly conveys polution from distributor to consumer. The greater the lapse of time between the deposit of pollution in a water supply and the drinking of that water, the better for the consumer.

In spite of the fact that there is a self purification of water through natural agencies, sanitarians of to-day discountenance the unfiltered use of an inland stream for water supply purposes.

The self purification of a stream may be satisfactory as regards the removal of nuisance, but there is no surety as to the bacterial purification at all times. There are many natural probable sources of pollution of these waters, so that sewage clarification to the extent of preventing nuisances should ordinarily be sufficient for sewage effluents entering most inland streams.

The placing of crude or clarified sewage in any body of water as a method of disposal, is spoken of as disposal by dilution.

4. Sewage Disposal by Dilution.—There are three general conditions governing the disposal of sewage by dilution:

1. Disposal by dilution in inland streams.
2. Disposal by dilution in lakes.
3. Disposal by dilution in tidal waters.

When disposing of sewage by dilution in inland streams, particular care must be observed with regard to the following:

1. The diluting body should show no floating matters which are offensive or which might strand on the banks of the stream.

2. A sufficient portion of the settling matters of the sewage should be removed to prevent the formation of mud banks; care should be taken to insure a proper relationship between the velocity of the stream and the size of the materials admitted to it.

3. The relation between the volumes of sewage and the diluting water should be such as to insure an aerobic decomposition of the sewage. It is also desirable to insure a residual oxygen content in the stream sufficient to maintain the major forms of fish life.

4. The question of a sewage containing a large amount of trade wastes will require a particular study for each case.

The removal of floating bodies which are objectionable or which might strand is very readily accomplished in any of the clarification processes:

1. Screening.
2. Sedimentation.
3. Chemical precipitation.
4. Septic tank process, either of the Cameron or the Imhoff type.
5. Single contact beds.

It should be distinctly noted that these processes are

simply methods of clarification, the sewage effluent from them is highly organic and unstable and must acquire from some outside source sufficient oxygen to complete the process of decomposition to a condition of stability.

Of the clarification processes noted, perhaps the most simple under favorable conditions is that of screening.

5. Clarification of Sewage by Screening.—The use of screens for the removal of settling and suspended matters has been extensively followed in Europe for some years and to-day we are employing them more and more, as the opportunity offers, as a method of clarification. Screens may be classed as coarse or fine. The first type consists of gratings or bars; the second are generally constructed as a net mesh.

Coarse screens are used to remove all gross refuse matter which might be objectionable. When sewage is pumped, screens are installed to protect the pumps. Such screens are generally limited to minimum clear openings of about one-half inch. In design they may be either of the fixed or movable type. The fixed screen may be of bars, iron or wood, set upright or horizontally. The fixed grillage is hand cleaned with a rake whose teeth fit the clear spaces. The upright screens are best set at a slight inclination, generally with the direction of flow. The movable grating may consist of:

1. Fixed rods with movable scrapers.
2. Movable rods with fixed scrapers.
3. Movable screens with fixed scrapers.
4. Movable screens with movable scrapers.

Screening devices require constant attention to prevent severe clogging and resultant backing up of the sewage, and should in general be installed in duplicate to admit of continuous operation.

The amount of screenings removed per million gallons of sewage clarified will vary greatly, depending entirely upon local conditions. So also will the cost of removing the screenings. Foreign practice appears to allow from ten to thirty square feet of screen per million gallons of sewage treated per day.

Fine screens or sieves deal primarily with the settling and the suspended organic matters. These screens are either fixed or movable and, to operate successfully, care must be taken:

1. That the screenings do not disintegrate on the screen
2. That no deposits are formed in the screen channel by the blocking of the screen and the backing up of the sewage.
3. That the screens be easily adapted to variations in flow.
4. That continuous operation be insured by easy interchange of screens or duplication of installation.

Various endless belts with different kinds of scrapers have been developed and have filled the particular needs in a satisfactory manner. These fine screens have a minimum mesh clearance of about one-thirteenth of an inch. General practice allows from ten to fifty square feet of screen per million gallons of flow.

Perhaps the most well-known fine screen developed in the country is the Weand Segregator. The original unit is installed at Reading, Pa., and has a capacity of eight million gallons' flow per day. This rotating screen consists of an iron and steel horizontal cylindrical frame, six feet in diameter and twelve feet long, upon which is placed forty mesh Monell metal wire cloth, protected by a five-eighths inch mesh copper screen.

The sewage enters at one end of the cylinder on a line with the horizontal axis, flows over a spreading plate and drops upon the screen. The water of the sewage passes through the cloth, while the solids are carried upward by the rotating screen till opposite a series of oscillating jets outside of the cylinder, which force them from the cloth. The screenings fall to the bottom of the cylinder and are carried by a worm conveyor to a point of storage.

This screen removes from thirty to thirty-five cubic feet of wet matter per million gallons of sewage screened. The screenings contain about ninety per cent. of moisture.

A screening installation of any type must accomplish certain definite results. The particular governing conditions will depend largely upon the relation between the sewage flow and the diluting stream.

6. Sewage Effluent and Diluting Stream.—All surface waters in their unpolluted state contain atmospheric oxygen to a greater or less extent, depending on such factors as temperature, atmospheric pressure, kind and quantity of aquatic life. When clarified sewage effluents are placed in these waters, this dissolved oxygen is utilized by the organic matters of the effluent to complete the process of decomposition. The relation between the volumes of effluent and diluting water should be such as to supply all the oxygen needed by the suspended and dissolved organic matters of the sewage. In addition thereto there should be unconsumed a residual oxygen content of from thirty to fifty per cent. of complete saturation, at the particular temperature and pressure.

When either crude or clarified sewage is placed in a stream in such quantity that it completely exhausts the oxygen content of the water, then the normal aerobic decomposition ceases. The unobjectionable process becomes a most obnoxious anaerobic one, with no final condition of stability.

This has been the experience of many cities in this country and of the larger cities of Europe which continued to discharge sewage into a stream without regard to the capacity of that stream to decompose sewage. The changing of the Thames into an immense cesspool was experienced by London during the summers of 1858-59, and has been most vividly described by Budd in his monograph on typhoid fever. "Stench so foul, we may well believe, had never before ascended to pollute this lower air. Never before, at least, had a stink risen to the height of an historic event. Even ancient fable failed to furnish figures adequate to convey a conception of this thrice Augean foulness. For many weeks the atmosphere of Parliamentary Committee Rooms was only rendered barely tolerable by the suspension before every window of blinds saturated with chloride of lime, and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law courts were suddenly broken up by an insupportable invasion of the noxious vapor. The river steamers lost their accustomed traffic, and travellers, pressed for time, often made a circuit of many miles rather than cross one of the city bridges."

The experience in the past of many American cities has led to the conclusion that a minimum flow of from 4 to 7 cubic feet per second per 1,000 of population sewering into a stream is necessary to prevent the formation of a nuisance; providing the stream has sufficient velocity to prevent the formation of sewage mud banks. Roughly, it has been found that a stream will purify one-fiftieth of its volume of sewage but not one-twentieth.

It is not possible to set definite limits as to the amount of sewage containing trade wastes, that may be cared for by a stream. Biological and chemical factors have to be very carefully considered. Wastes containing objectionable foreign particles, acids, or alkali, or other materials poisonous to the life in a stream create entirely different conditions from

those obtaining when domestic sewage alone is discharged into a stream.

7. Summary and Conclusions.—Sewage is a mixture of highly complex organic substances and, under certain conditions, will form offensive decomposition products. Sewage may contain pathogenic organisms in large numbers.

A satisfactory disposal by dilution, whether preceded or not by a clarification process, is only to be had in streams possessing a satisfactory diluting volume. Streams having a large variation between maximum and minimum flow conditions, are particularly liable to give rise to nuisances.

Satisfactory disposal by dilution implies the avoidance of physical nuisance; it does not imply a satisfactory bacterial removal.

The streams of California, with the possible exception of the Sacramento and the San Joaquin, do not exhibit sufficient dry weather flow to receive the clarified sewage of communities, and so dilute it as to avoid nuisance.

All questions of legality waived, it would seem that natural stream conditions in California preclude the consideration of sewage disposal without purification.

This conclusion is based on the impossibility of avoidance of stream nuisance.

HYDRAULIC DREDGE "PORT NELSON."

The 24-inch hydraulic dredge "Port Nelson," built by the Polson Iron Works Toronto, for the Department of Railways and Canals, was successfully launched on Saturday, May 31st, five weeks after the material was ordered, which constitutes a record in the history of Canadian shipbuilding. It was christened by Mrs. Hearst, wife of Hon. W. H. Hearst, Minister of Lands, Forests and Mines in Ontario. The contract for the dredge, which amounted to $270,000, was placed by the government in the beginning of April and the company expect to deliver the dredge in Montreal before the expiry of the contract time. It was designed by Wm. Newman, M.I.N.A., and following is a description of the dredge: The dimensions of the hull are as follows:—

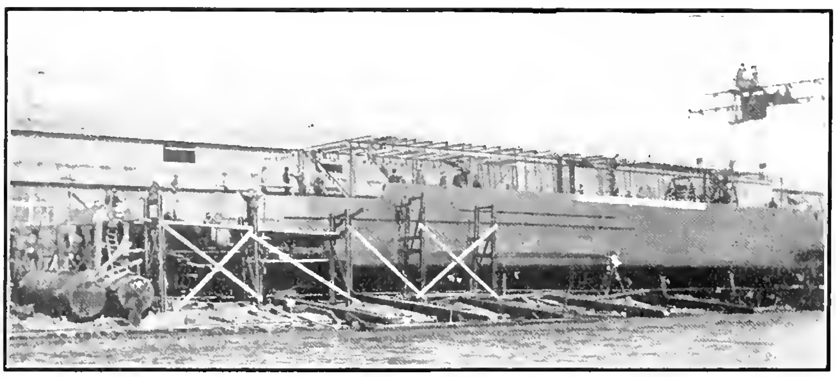


Fig. 1.—Showing the "Port Nelson" on the Ways.

Length	180 ft.
Beam over all	44 ft.
Depth at side	11 ft.
Draft, about	6 ft.

The dredge is to be of scow model with a spoon bow, as shown on drawings, and is to have circular bilges with 18-inch radius. All material and scantlings are designed up to, and in most cases above, Lloyds' requirements.

As the dredge will be towed around the Labrador coast to her destination, which is Port Nelson, and for which the government are now calling for tenders, her design and structure throughout are being made amply strong to enable her to take this trip with safety, the shell plates being ½ inch throughout, and keel plates ⅝ inch. The sheer plate extends 3 feet above the main deck and is surmounted by heavy steel bulwark rails, these lending additional longitudinal strength to the structure.

The deck stringers are ⅝ inch thick, and the deck itself is ¼ inch chequered plate. The deck housing is of steel structure of ¼ inch plate, and will be divided into three parts by two longitudinal watertight bulkheads. The framing is exceptionally heavy, with 10-inch channel floors weighing about 25 pounds to the foot, and located 20 inches apart. The side frames and deck beams are all 6-inch 15-pound shipbuilding sections. The longitudinal girders used are of 15-inch channel, 35 pounds to the foot, and the longitudinal truss frames are of 12-inch 25-pound channels.

There are two 26-foot metallic life boats and two life rafts.

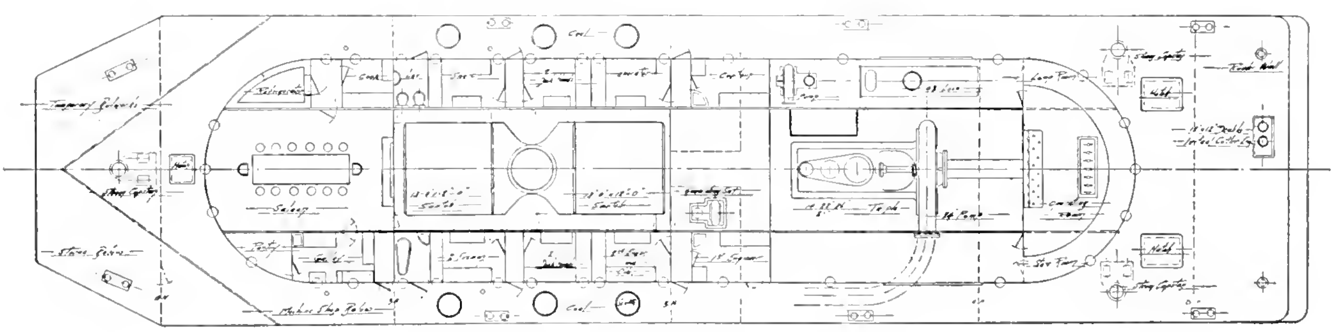


Fig. 2.—Showing Plan of the "Port Nelson."

The dredge will be equipped with a complete electric light outfit and search lights. A complete machine shop outfit consisting of air compressor, planer, lathe, drills, etc., will be installed so that the dredge will contain the necessary outfit for effecting any repairs required from time to time.

It will have a discharge pipe of 24 inches in diameter, and the hull will be divided into six water compartments by five transverse bulkheads.

The main engine for driving the pump is of the marine triple expansion type; cylinders 14 inches and 22 inches and 36 inches in diameter by 21-inch stroke. There are two Scotch boilers 13 feet in diameter by 12 feet long. In addition to these there is an auxiliary boiler of the locomotive marine type situated on deck, being 48 inches in diameter by 14 feet long, and alongside of this is an 8-inch wrecking pump.

The dredge will be equipped throughout for salt water service, with surface condenser and copper piping. The circulating water will be supplied by an 8-inch centrifugal pump driven by a 6 x 7-inch vertical engine. The air pump is of the vertical simplex beam type. It will also be equipped with feed and bilge pumps. For the purpose of raising and lowering the suction pipe, a 12-inch by 12-inch, two-cylinder double-acting engine will be provided on the main deck forward. There will also be three capstans provided, operated by 6-inch by 8-inch double-acting engines. The boom for raising and lowering the suction pipe is located at the suction end of the dredge, is 64 feet in length, and is built up of steel shapes and plates throughout.

The cutter engine consists of 12 x 12-inch two-cylinder doublt-acting horizontal engine. The cutter head is 5 feet in diameter, with a spare cutter head 4 feet in diameter.

A general fire service pump, hand deck pump, and necessary hose to reach all over the ship will be furnished with the dredge.

The gallery, dining room, cabin and crew's quarters will be fitted up and furnished complete. The dredge will also be supplied with 3,000 feet of piping and pontoon for the discharge. It will commence operations at Port Nelson this summer, where a harbor thirty feet deep at low tide will be dredged, thus giving Canada her first ocean port of any importance on Hudson Bay. Some $4,000,000 has been appropriated by the government for this year's work, which will be supervised by Mr. H. T. Hazen, engineer for the Department of Public Works.

STANDARD OF ABRASION FOR PAVING BRICK.

The organizations of city officials interested in standardizing paving specifications adopted a standard rattler for making abrasion tests and standard methods of making the tests but did not see fit to specify the maximum allowable amount of abrasion until a year or so ago. After two or three trials the specification has been set at 22 per cent. with proviso in the specifications of the American Society of Municipal Improvements that "where medium or light traffic or other conditions exist which, in the opinion of the engineer, do not require a brick capable of giving an abrasion loss of only 22 per cent., brick of a quality which will give a loss of 25 per cent. or even 28 per cent. may be used.

SPECIAL LIBRARIES' ASSOCIATION.

The fifth annual meeting of the association will be held at the Hotel Kaaterskill, Catskill Mountains, New York, June 24th to 26th, 1913.

Information regarding hotel arrangements can be had from Harrison S. Downs, 19 to 21 West 44th Street, New York City. Travel information can be had from F. W. Faxon, chairman, Travel Committee, 83 Francis Street, Boston. An attractive post conference trip will be arranged by the travel committee in the Lake Champlain district.

COAST TO COAST.

Vancouver, B.C.—Timber as an asset of provincial wealth is daily becoming of greater value. With the opening of the Panama Canal and the free entrance of lumber into the United States, British Columbia timber will, it is predicted, be more sought after than ever. "The day of $2 timber is long past." was the answer of Mr. R. C. Bidlake, of the Snowdon-Bidlake Logging Company, of this city, when asked concerning the value of standing timber. "Values are advancing rapidly, and it is impossible to-day to buy at anything like the figures of a year or two ago. For good timber that can be taken out at a reasonable cost, say, on Crown grants, it is very doubtful if anything can be bought under $2.50 a thousand feet, taking the general run of the cruise, and figures over that are happening every day. Only a week or so ago a tract of one hundred million feet on Menzies Bay, Vancouver Island, was sold for $3 per thousand feet, and another recent purchase of a tract a little smaller also went at $3. Then there was the purchase on the Lower Lillooet a few weeks ago, also quoted at $3. Crown-granted timber is in strong demand, and very few small tracts can be had for less than $3. That it is being paid shows that the timber is worth it. Besides, at that figure buys are good, since values are advancing. A factor in determining values also is whether the logs have to be towed down the coast, for losses are bound to occur."

Edmonton, Alta.—The city council has authorized the commissioners to spend $125,000 upon further provision for the sedimentation and filtration of water at the present pumping station. This sum is to be used in the construction of a 5,000,000 gallon sedimentation basin and filter units with a total capacity of not less than 4,000,000 gallons, together with a clear water basin to take care of the same. In this connection the commissioners reported as follows: "We feel that this is not making too great a provision to take care of the water in the interval between now and the time that the new waterworks scheme might be ready for operation. If this amount is authorized, work can be proceeded with very shortly with the construction of a sedimentation basin, and tenders received for the construction of the filters and the clear water basins. We estimate that the sedimentation basin will cost in the neighborhood of $50,000; filters and clear water basin, $64,000, the housing, pipes and incidentals to make up the balance. Judging from the increase of population during the past year, and taking the same percentage of increase for another four years, our population will then be in the neighborhood of 120,000, and the provisions made are not too ample to take care of, and give satisfactory service for, the intervening years." A motion was made and adopted that the report be accepted, that the commissioners be instructed to proceed with the work specified this year in order that the filters may be in operation by next spring, and that the city solicitor bring down the necessary by-law covering the expenditure. If good progress is made upon the work there should be no more muddy water at the time of the spring freshets, which will become forever a matter of painful memory—the muddy water, not the freshets.

Montreal, Que.—Mr. Norman M. McLeod, contractor in charge of Montreal's big filtration plant, to cost about three million dollars, has sent a notarial protest to the city, saying that the structural design is unfitted for the bearing power of the soil, as proved by the subsidence of certain work. He says that he will do the repairing to the cement work damaged by frost. but he wishes to be relieved of all responsibility for the failure. The protest recites the history

of the contract and the notice received on April 3 to make good damage to cement, which was attributed to frost. Mr. McLeod says also that on May 12, the city protested to him to go on with and make good the work said to have been damaged by frost, and repudiating his charges of defective foundations. The following serious errors in the design of the structure are named by Mr. McLeod: 1. In regard to the original irregularity of the surface of the ground, which necessitated lowering high places and filling in low ones, thus offering unequal bearing capacity for the foundations, the structure should have been designed to provide for footings of proportionate bearing capacity to prevent unequal settlement. 2. That the structural features of the building should have been designed to be separate and distinct from those features dictated particularly by the object for which the building is to be used, the footings and piers being carried down to a firm foundation separate or otherwise, supported with due regard to the nature of the material on which the structure is to be founded and independent of the floor. 3. The construction and design of the arch system is such as to have aggravated any damage or disturbance beyond what would ordinarily occur. 4. The floors and walls should have been designed to be absolutely watertight in view of the fact that even so small an amount of leakage as that allowed by the specifications into soil of the nature in question will undoubtedly cause settlement or subsidence, which must result in the cracking of the floor walls and the certain failure of the structure.

Ottawa, Ont.—At the sittings of the Board of Railway Commissioners to be held in Ottawa on Tuesday, June 17th next, the board will take into consideration the proposition that, by limiting the height of freight cars operated on railways subject to its jurisdiction to 13 feet 6 inches from the top of rail to the running board, trainmen would be safeguarded, and grade separation facilitated; also of the proposals submitted by the Canadian Freight Association in conformity with the suggestion that this object would be promoted by basing the minimum weights of the Canadian freight classification for light and bulky articles on the cubical capacity of box cars, instead of on their length, as at present.

Ottawa, Ont.—The Government has decided to institute a new departure in connection with the forestry branch which will undertake the work of investigating the possibilities of conserving our forests by reducing waste in manufacture, by prolonging the life of forest products used in construction, and developing uses for products now wasted for the lack of knowledge as to how they may be employed. To take charge of this work Hon. W. J. Roche, Minister of Interior, has selected A. G. MacIntyre, at present editor of the "Pulp and Paper Magazine," and acting secretary of the Pulp and Paper Association. Mr. MacIntyre is a graduate of Acadia University, and he also graduated from McGill University in chemical engineering. He was chemical engineer of the Jonquiere Pulp Company, where he had charge of the water power, water discharge measurements, etc., and he put in a bleaching system of his own design, saving in the value of the paper. He was also engineer in charge of construction for Price Bros. at Kenagami, Que., and did the investigation for the new sulphite mill. His special qualifications should assure the successful carrying out of the project. The work will be carried on at present in co-operation with McGill University. The various classes of investigation to be carried out will be as follows: Wood tests, timber physics, wood preservation, wood distillation, and wood pulp. This is an advanced step on the part of the Department of the Interior The forestry branch is one in which Dr. Roche has been particularly interested, and this new step is along the lines of modern scientific forestry work in Germany and other European countries. To fulfil the prime object of forestry, which is to preserve and conserve our forests, it is felt this line of development must be undertaken.

Calgary, Alta.—That it will be inadvisable to establish a filtration plant on a large scale until Calgary definitely settles the question of source of water supply is the emphatic statement of Waterworks Engineer A. Ellison Fawkes. Mr. Fawkes discussed the situation at some length after having consulted Saturday with T. Aird Murray, of Toronto, one of the recognized authorities on water supply in America. At the present time Mr Fawkes is having erected a temporary chemical purification plant which will be part of the pumping station supplying water from the Bow River as a standby to the Elbow River gravity system. This pump will afford a 20,000,000 gallon supply daily from the Bow River, and the water will be treated with hypochloride and sulphate of aluminum. At the present time, the water taken from the Bow is treated only with hypochloride, which effectually kills all germicidal life. The addition of aluminum sulphate to the water, however, will also remove suspended matter and the chemical precipitates, giving a clarity of about 75 per cent. The hypochloride makes the water practically pure so far as typhoid and the like are concerned, having an efficiency of about 98 per cent. The by-law carried an appropriation for $50,000 for the establishment of a turbidity filtration system in connection with the Bow pumping station, but Mr. Fawkes decided that it would be impossible to erect a proper filtration system at this point under a cost of $400,000. To spend such a sum on a filtration plant when the city is as yet undecided whether the supply shall ultimately be obtained by gravity from mountain streams or lake in the Rocky Mountains, the waterworks engineer considers foolish. He discussed these points with Mr. Murray when that expert looked over the water situation here, and Mr. Murray agreed that the temporary chemical treatment of the water is the best solution of the problem at present. It costs less than $500 to install the chemical treating apparatus at the Bow River station, and it will soon be in working order. According to Mr. Fawkes, the aluminum sulphate not only removes suspended particles from the water, but also removes the chemicals after their work is done. When added to the water, the aluminum sulphate spreads out in a glutinous form and collects the infinitesimal particles of suspended matter, the dead germicidal matter which has been killed by the hypo-sulphide, and also the precipitate formed by the hydro-sulphide after the chemical reaction takes the addition of the aluminum sulphate and is then strained out through a series of screens. The water comes out 98 per cent. pure, so far as germ life is concerned, and 75 per cent. clear of suspended matter as silt, clay and the like.

Port Coquitlam, B.C.—Engineers for the cities and municipalities on the route of the proposed highway to Port Coquitlam have begun preliminary surveys of the grades with a view of estimating the cost. It is probable that a new road will be built between the North road and Port Moody on an easier grade than that of the present highway. The engineers forming the party were: City Engineer Fellowes, Vancouver; Engineer McPherson, Burnaby; Col. Davis, Port Moody; Engineer Kilmer, Port Coquitlam. In addition to the new road from the North road to Port Moody, City Engineer Fellowes believes that there ought to be a new route from the Vancouver city boundary to Barnet to eliminate some of the heavy grades on Hastings Street. He also advocates that Pender Street be made the main route out of the city because of Hastings Street being a car line thoroughfare. Profiles will be drawn of the various sections and another meeting will be held later. The plan will then

be laid before the Provincial Government with a request for financial assistance.

Vancouver, B.C.—Encouraging reports of the manner in which the interior of the province in the Hope district is filling with ranchers are brought back to the city by Mr. George D. McKay, provincial timber inspector, who returned to this city recently after a visit of inspection of the forest fire protection service. "It is four years since my last visit to the district, and I was amazed at the great alteration," said Mr. McKay. "All along the route of the new Pacific Highway the land is occupied with ranches, and the country looks prosperous. The Pacific Highway is going to be a wonderful thing to enable our residents to see the scenic beauties of the province, and will attract thousands of wealthy automobilists here, too," said Mr. McKay. "The roadway is being cut through a hundred-mile stretch of the most wonderful scenery imaginable. It is twenty-four feet wide all the way, and will start from Chilliwack and run clear through to Hope, and thence on to Silver Creek and the summit of the Cascades, striking the old Dewdney and Similkameen trails to Nicola and the Boundary country. There are wonderful views of mountain and valley scenery, nearly the whole way. It will be one of the great resorts for automobilists who want to see Nature at her grandest." Superintendent Sutherland and his staff of 100 men have already got sixteen miles of road in the Yale district completed, and are following up the work as fast as the snow disappears in their path. Mr. McKay does not anticipate any danger from floods in the Chilliwack district unless the thaw from the mountains should be delayed, and a heavy drainage comes down toward the middle of June, when a high tide is due. The tide from the ocean backs up the waters of the Fraser River as far as Sumas, and the danger to be feared is that the high tide should come at a time when the river is swollen with the mountain thaws.

PERSONAL.

MR. DOUGLAS SPENCER, of London, England, arrived in Toronto this week. Mr. Spencer's visit is a strictly business one. While here he is making his headquarters with the Canadian Boving Company of this city.

MR. GEORGE IRVINE has been appointed Canadian manager for the National Meter Company, of New York. Mr. Irvine will make his headquarters at 229 Spence Street, Winnipeg. He is a Canadian by birth and fully familiar with conditions existing in Canada. He has been in the employ of the National Meter Company for nearly twenty years, and has had long practical experience in connection with waterworks matters.

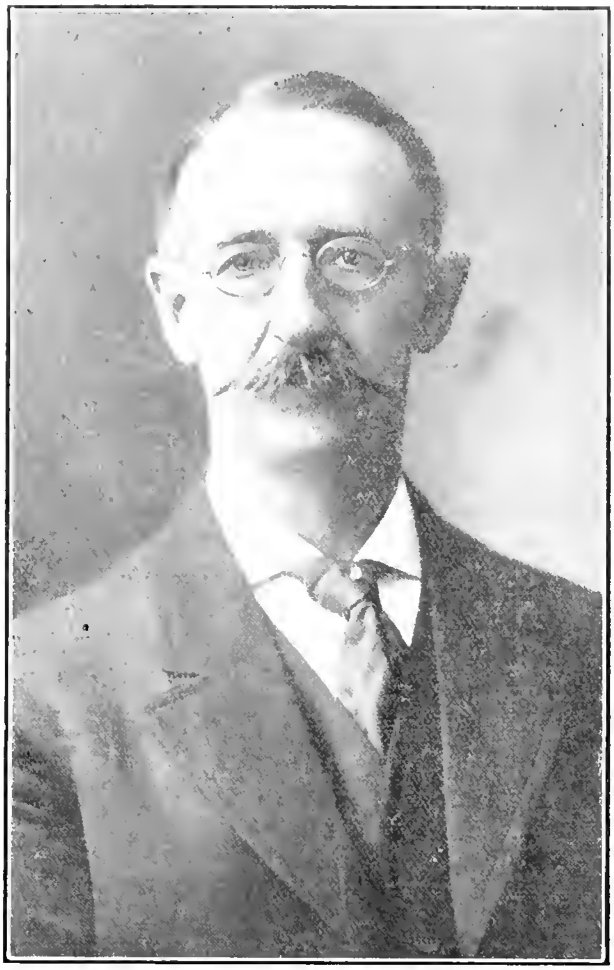
MR. SAMUEL HILL, president of the American Road Builders' Association, at the invitation of President George McAneny, of the Borough of Manhattan, and President Cyrns C. Miller, of the Borough of the Bronx, New York City, on May 26th delivered an illustrated address on the subject "The Highways of the Northwest" at the residence of President McAneny, before an assemblage of over fifty municipal engineers who are in charge of the highways of Greater New York.

OBITUARY.

MR. J. K. McLEAN, Dominion Land Surveyor at the Sarcee Reserve, near Calgary, died on May 23. Deceased was the eldest son of the late Donald McLean, formerly collector of inland revenue in Guelph. He was a resident of Ottawa.

THE PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

It gives us great pleasure this week to be able to present to the readers of *The Canadian Engineer*, a portrait, together with some facts relating to the career of Professor George F. Swain, President of the American Society of Civil Engineers, which society is to hold its summer meeting in the city of Ottawa this month. Owing to the fact that many of our readers are members of both the Canadian and American societies, we feel they will be interested in learning something about the career of Professor Swain.



Prof. Geo. F. Swain.

George Filmore Swain was born 2nd of March, 1857 in San Francisco. His father was a prominent citizen of that city and a leading merchant. It was while he served as president of the Chamber of Commerce, that he was appointed superintendent of the branch mint during the Presidency of Abraham Lincoln. Swain, Jr., received his preparation for college at a military school. When sixteen years of age he became a student at the Massachusetts Institute of Technology. His teacher in civil engineering was Professor John B. Henck. In 1871 Mr. Swain received the degree of Bachelor of Science. This was followed by courses of study in Berlin, Germany, where he specialized in bridges, railroads and hydraulics. He returned to the United States in 1880, and shortly after was appointed instructor in civil engineering at the Massachusetts Institute of Technology. He was soon promoted to the position of assistant professor, and a few years later, in 1881, became full professor in charge of

the department of civil engineering. In 1909 Professor Swain was offered and accepted the Gordon McKay professorship of civil engineering in the graduate school of applied science, Harvard University. In 1893 upon the organization of the Society for Promotion of Engineering Education, he was appointed the second president of that society. His publications include Notes on Hydraulics and also on Structures, for the use of his classes. In 1887 he contributed a paper to the American Society of Civil Engineers on the "Calculation of Stresses in Bridges for Concentrated Loads," which paper has had a very marked effect upon present practice so far as structural computations and investigations are concerned. Professor Swain has served on a number of different commissions, among them being the Boston Transit Commission organized for the construction of the Boston Subways; the commission appointed to fix the method of eliminating grade crossings in various parts of New England, and has in very many cases been called as an expert in court cases, not only in Massachusetts but elsewhere.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memorial Museum, Ottawa.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, E. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. H. W. Claudet, J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Pingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 23. Toronto, June 12, 1913

Contents of this issue on page 851

The Canadian Engineer

An Engineering Weekly

DESIGN OF A STRUCTURAL STEEL PLANT

THE HANDLING OF EQUIPMENT AND MATERIAL—LIGHTING AND POWER FACILITIES—COMPRESSED AIR AS A POWER TRANSMITTER—WATER SUPPLY AND DRAINAGE

By E. H. DARLING, M.E.*

(Continued from last issue, page 818.)

HANDLING Machinery and Industrial Tracks.—Next to the selecting of the machinery there is no one feature about a structural steel plant that should receive more careful consideration than the handling equipment. The cost of handling is the largest item in the labor account, and the capacity of the plant depends a great deal on the speed with which material is fed to and taken away from the various machines. Even after every unnecessary motion is eliminated, there is a great deal of handling to do to each piece and the weight, length and flexibility of most of them call for care and special appliances.

In the ordinary run of work it is seldom that a piece of material from the steel mills will exceed three tons in weight. The stock yard crane, however, should have at least ten tons capacity as it is usually desirable to lift several pieces at one draft. Only one crane, having a ninety-foot span, travelling the full width of the lot, will be needed at first. At some future time another crane and runway may be added, which will not only increase the handling capacity, but will double the area of the stock yard.

This yard crane will unload material from the cars and sort it. As it is required in the shop, it will be put on small trucks which run on narrow-gauge tracks from one end of the shop to the other. Inside the building the hoists on the bottom chords of the trusses afford a means by which the material may be taken off the trucks and transferred to any point across the shop. At each end of the building, however, on account of the great deal of handling that takes place, at these points, it is advisable to have travelling cranes of about sixty-foot span—a 10-ton crane at the stock yard end and a 15-ton crane at the shipping end. These cranes will also be found of great service in transferring material from one aisle to another.

At the punches, longitudinal trolley beams with trolleys and chain hoists are necessary to hold the work as it is fed through the machine. These trolley beams must be suspended below the trusses and have openings for the trolleys on the trusses to pass through. Special travellers and jib cranes can be arranged to suit the need of any particular machine.

In that part of the girder shop where the girders are assembled and handled, it will be necessary to have two travelling cranes of thirty-ton capacity. Travelling jib cranes for carrying riveting machines can be arranged to run along the east side underneath the over-head cranes. In the structural shop the riveters will have 3-ton travelling cranes with fifteen-foot span carried on runways suspended from the roof trusses.

Three- and five-ton air hoists will be required wherever much lifting is to be done, provided the head room is sufficient for the hoist. For holding work at machines, however, a chain block is better, as air hoists are not steady enough. Wherever possible, material will be laid on horses or skids, so as to save raising and lowering more than necessary. If much of it has to be done at any point, rapid-acting blocks should be used

In course of time it will be found convenient to have a thirty-ton travelling crane with seventy-five-foot span in the yard at the north end of the plant. Under it finished material may be stored and loaded for shipment as required. It can be used for assembling large trusses when it is necessary to put them together at the works before shipping.

All the thirty-ton cranes should have 5-ton auxiliary hoists, or should be provided with change gears, as some cranes are now made. This will save a great deal of time when the crane is used for handling light pieces, the slow motion or main hoist being used only for heavy loads.

The handling equipment under certain conditions should include a 10-ton locomotive crane. Such a machine will be found of great service during construction for unloading and placing building materials, machinery, etc. It will also be a great convenience, if not a necessity, in moving cars, unless unusually good shunting service is available from the railway company. It may be used to good advantage by the erection department for certain work.

All parts of the handling equipment should have a wide margin of strength. Chains, hooks, cables, chain blocks, etc., that are frequently overloaded, soon give trouble and become dangerous. The most serious accidents of a structural steel shop are the result of falling material.

Power and Lighting Systems.—Electric power is usually delivered as two- or three-phase alternating current at a high voltage, to be transformed to suit the requirements of the purchaser. For distribution about the plant a voltage of 220 or 500 volts is usually used. The higher voltage requires less copper in the feeders, but for a structural shop the lower voltage, i.e., 220 volts, is preferable. The presence of so much metal, the rough treatment which wires and conduits are liable to receive, makes it unwise to use a voltage that might be dangerous to workmen.

* McPhie, Kelly & Darling, architects and engineers, Hamilton, Ont.

The power equipment must include a motor-generator set, as direct current will be required for variable speed motors, such as cranes, reamers, etc. The motor side of this set should be of the synchronous type with sufficient capacity to correct the power factor of the plant. On account of the varying loads on the motors, the power factor is sure to be very low. The capacity of the generator should be well able to take care of the needs of the plant, including the lighting system and the extra travelling cranes which might be added in a year or two. A set with a capacity of 100 kilowatts direct current and a synchronous motor of 125 k.v.a. should give satisfaction.

The high voltage current will be brought down the tower at the end of the power house to the transformers, and from thence the low voltage current will be taken in conduits to the bus-bars of the switchboard. A separate switchboard will be needed for the direct current system. From the switchboards feeders in conduit will run to the machines in the power house and template shops. For the main shop the feeders will pass up the tower and over head to cross-arms on the trusses of the building. A separate system, each on its own switch, should be provided for the different departments, so that any one can be cut out without interrupting the others. There should be three sets of A.C. feeders, one for each aisle of the shop, with room on the cross-arms for the additional aisles to be added later. There should be two pairs of D.C. feeders, one for the north cranes and one for the south cranes. If separate switches are provided at convenient points for cutting out each crane, it will hardly be necessary to have separate feeders for the other D.C. machines in the shop. There will only be one or two of these machines other than the reamers.

All wires above the bottom chord of the trusses will be carried on cross-arms bolted to the steel work, but wires below this level must be put in metal conduits. The starting switches for each machine should be as near the machine as possible. For the portable reamers a series of outlets must be provided on the columns about every forty feet down the shop so that the reamers can be connected up by means of a plug and a flexible chord wherever needed. Each outlet and, in fact, every branch circuit, must have a separate cut-out. In this and in all other particulars the rules of the fire underwriters must be followed, and every precaution taken to prevent short circuits and injury to the workmen.

For general illumination modern D.C. flaming arc 110-volt lights give as suitable and as economical a light as any. One light in every other bay arranged alternately on the right and left-hand side of the centre of each aisle will be sufficient for general illumination, while they may be spaced closer over the laying-out skids and the assemblers. As the power circuit is 220 volts, it will be necessary to connect two lights in series. Each pair must have a cut-out and every four lights should be controlled by a two-pole switch.

Sixteen-candle-power incandescent lights must be provided for each machine. These must be on good lamp chord and protected by wire cages having wooden handles. The power for these lights may be obtained by tapping the circuit that supplies the machine.

For the template shop the best illumination can be obtained by means of 100-watt tungsten lights suspended from the roof, three in each twenty-foot bay. Along the walls, over tables, or near machines, 16-candle-power carbon lights on drop chords will be used to give special illumination where needed.

Compressed Air Systems.—The transmission of power by means of compressed air is a very expensive method, but it is so convenient to handle, and can be adapted to so many uses, that it would be impossible to get along without it. A pressure of 90 to 100 lbs. per square inch is usually used for operating pneumatic riveters, hammers, reamers and hoists. The plant can easily be supplied by a 700-foot-per-minute, two-stage compressor. When the demand gets beyond this, it will be advisable to add a 1,400-foot machine to the equipment and the piping, etc., should be installed at the outset with this object in view. By having two machines of different capacity, the varying demand for air can be supplied a great deal more economically than by one large compressor.

The compressor will be belt-driven by a 125-h.p. induction motor. It should have an automatic throttling device which will cut off the supply of free air completely when the pressure in the system reaches its maximum. Such a governor can be adjusted to regulate the pressure within three pounds. This small variation need not be considered, as the method is much more economical in power than if a regulator were used which would permit just enough air in the intake to maintain the pressure constant. It causes great fluxations in the power used, however, as the compressor runs light when the intake is cut off.

In order to keep the pressure in the distribution system as constant as possible, and to relieve it of shocks, it is necessary to have a storage tank near the compressor. This tank will also act as a cooler, and in it will collect a great deal of the moisture that would otherwise pass into the distribution pipes. A large second-hand fire-tube boiler can be converted into a splendid storage tank. It should be set in a vertical position so as to allow a natural circulation of air through the tubes. The inlet should be near the top and the outlet about eighteen inches from the bottom. A convenient place for this tank is in a corner of the boiler-room. From it the air main can be taken underground to the centre of the main shop, and from thence by three vertical branches to the roof trusses, one branch each for the air hoists in the girder shop and structural aisles and one branch with drop pipes down every other column of the centre row, having outlets for the riveting machines, reamers, etc.

All horizontal pipes should be given a slight slope downward in the direction of the flow of air so that any moisture that is carried past the storage tank will not obstruct the flow. At the tank and at all low points in the system blow-off valves must be provided to the drains, and these should be opened at regular intervals. Care in this particular and abundantly large pipes will do away with all trouble from frost in winter. It will not pay to provide special means to re-heat the air before using, and it is not convenient to arrange a satisfactory indirect method.

A low pressure system—about twenty pounds per square inch—will be required for the oil forges. The blower, which will be driven by a small motor, can be supported between the trusses. The distribution system, which will be made of galvanized iron pipes, will be carried over head and down columns near the rivet forges. Ultimately a separate blower will be required for the rivet-making plant and the blacksmith shop, but for the present the one machine will do.

Water Supply System.—Apart from the amount of water required for drinking, sanitary purposes and fire protection, it will only be used for the water-cooler of the compressor, and in the boiler of the heating plant. A 6-inch pipe will supply enough for several fire streams if the pressure is good. The source of supply will probably be a public main on the street to the north of the property. The best place to bring in the private main is along the west boundary. Here it will be always accessible and not likely to be covered up with materials, etc., and furthermore, in case of a break it cannot do much damage to tracks or foundations. Where the first branch in the main occurs a manhole should be

built and a valve placed on both lines leading away from it. In fact it will be found of great convenience to have plenty of valves in the system so that any one section may be cut out with the least possible interference with the rest of the system. It is most important that the supply for the water-cooler on the air compressor be as independent as possible, for the lack of a little water here will practically stop the operation of the plant.

Hydrants should be placed at convenient points, but not too near the buildings. By having them near the tracks they may be used for supplying the locomotive crane. An automatic sprinkler system should be installed in the template shop.

The ends of all branches should be arranged with plugs or caps so as to permit of being extended as the plant grows, and tees should be put in at points wherever there is the slightest possibility that a branch might be needed in the future.

Sewers and Drains.—The drainage system and its arrangement will depend entirely upon local conditions and the amount of fall obtainable. With a minimum grade of ⅛ inch in one foot for a twelve-inch glazed tile sewer it will require three such to properly drain the plant as first constructed. Assuming that they empty into a trunk sewer on the street and that they are to be four feet deep at the manhole in the stock yard, the trunk sewer will have to be at least thirteen feet deep where the drains enter into it. If the depth be a little more than this, something might be saved in cost by running one twenty-four-inch sewer about three hundred feet into the property and connecting the twelve-inch sewers to it. The question of sewers, however, depends so entirely on local conditions that nothing in the way of a definite design can be worked out at this stage. In general, however, it may be said that in addition to providing for carrying off the rain water from the buildings and the sewage, the surface water that may collect on the site must be taken care of. Special care should be taken to keep the sub-grade of the tracks well drained. All pits for machinery and other low spots should be connected with the sewers as well as all drain-offs and drips from water tops, steam pipes, etc. Sewers other than tile drains should not run near foundations if it can be avoided. In case such arrangement is found necessary, then the foundations must be carried down below the level of the sewer. Manholes with catch basins should be built at all junctions of the large sewers.

Fuel Oil System.—Where light fuel oil of a uniform grade and at reasonable price is readily obtainable, its use in riveting heating forges and other furnaces is well worth considering. The rapidity with which a furnace can be heated, the ease in obtaining a uniform temperature, and the absence of the dirt incidental to the use of coal and coke, are all points in its favor. Only satisfactory results can be obtained, however, from a correctly designed system, and while for a small plant the first installation will be expensive, it may be easily extended in the future at very little cost.

The great secret of success with fuel oil is clean oil of a uniform grade, and large distribution pipes. For storage purposes two 12,000-gallon iron tanks will be required. These are to be buried in blue clay near the tracks at least thirty feet from other buildings, so that a tank car may be unloaded into them by gravity. The tanks should have one end exposed in a pit or concrete cellar roofed in to protect it from the weather. This pit should be large enough to contain a small electric pump which will be required to maintain a sufficient pressure in the distribution system. The first tank serves as a receiving and settling tank. The second tank is connected with the first by a pipe so as to draw off the oil a foot or two from the bottom of the first. It will be necessary to drain the sediment out of the settling tank at regular intervals.

The distribution system should not be made of less than 1¼-inch pipe and should form a closed circuit or duplicate system, having a return pipe or overflow back to the second tank. By this means the oil is kept circulating at all times, and congestion from any cause is prevented. If trouble should occur at any point, that section may be cut out by means of valves and the rest of the system need not be interrupted.

For keeping the oil from congealing in winter, steam coils should be put in the storage tanks and the distribution pipes should be laid in iron casing through which steam may be blown.

Heating System.—The question of heating structural steel plants deserves special consideration in each particular case. It is a question that is involved in the choice of a location. To heat brick buildings of ordinary type is not necessarily a very difficult problem. The office can be heated by means of steam coils in the usual way. For the template shop, compressor room and machine shop a hot air system with fan will give satisfactory results if properly designed. This system is cheaper to install than steam coils and interferes less with the arrangement of the benches, machines, etc.

The heating of the main building is a more difficult problem. The volume of air to be heated is so great, uncontrolled by partitions, the conductivity of the corrugated iron and glass which forms the walls is so high, and the large doors have to be opened so frequently, that the cost of a plant that will give satisfactory results is almost prohibitory, to say nothing of the cost of operating it. Then, again, the capital invested in a heating plant lies idle a large part of the year. In fact, in Southern Ontario severe weather seldom lasts more than a few days at a time at intervals during the winter months. Under such conditions a heating plant is not necessary as "salamanders" or open fires burning coke or charcoal can be placed around at convenient points. The cost of such fires, even with the time lost by the workmen in keeping warm added to it, will not equal the interest on a heating plant and the cost of operation.

If care is taken to make a corrugated iron building air-tight, it will be found to be much warmer than such a building is usually expected to be. Large glass areas, such as are becoming so common in manufacturing buildings, if in a south wall, will produce the same warming effect which takes place in a greenhouse. This will add very materially to the warmth of a building on bright days, but it must be counteracted in summer time by good ventilation and circulation of air. Ribbed glass must also be used to diffuse the light.

Erection Equipment.—The equipment required for erecting steel work is merely to be mentioned here to call attention to it as being an item not to be overlooked. Such equipment depreciates so rapidly and the requirements vary so much with every contract, that a large part of the cost of it should be charged up to the work on which it is first used. This should be taken into consideration in making up the estimate for a piece of work. Special equipment, such as travellers, derrick cars, etc., can safely be left for consideration when the time comes to take contracts that require their use.

Order of Procedure in Construction.—When sufficient capital is immediately available the owners will very probably want the plant ready for full operation just as soon as possible, even if it costs more to rush the work. If, on the other

hand, only a portion of the necessary money is to be had at once and it is desired to start manufacturing in a small way at first, then the procedure will be somewhat different.

If at all practicable, it will be best to arrange so that the actual work of manufacturing will begin in the spring or early summer. It will be easier to hold a new organization together during the summer and get them in working order than it will be in the winter. Construction should be started in the early fall so that the water service sewers, tracks and all foundations for buildings may be finished, and the power house and template shop closed in, before cold weather stops the outside work. During the winter the electrical equipment and the compressed air plant can be installed and the template shop fitted up for work. The structural steel for the main building can be erected and the orders placed for the rest of the machinery for delivery in early spring. Orders for raw material should also be put in so that it may be on hand when the time comes to start work.

As soon as the weather permits, the foundations for the machinery may be built and the main building completed. Then, as fast as the machines arrive they may be set up and made ready for operation. In the meantime the template shop has prepared templates and the raw material has been marked for punching; thus gradually the different departments are organized. By the end of May or even earlier, shipments of finished material are being made.

If the above plan of construction is followed, it will be necessary to have another company fabricate the steelwork for the power house and the main building. Or, if desired, only one aisle of the main building may be thus arranged for and the rest of the steel work, including crane, runways and bridges, can be manufactured at a reasonable cost on the spot. This, however, would mean some delay in the completion of the buildings.

THE INFLUENCE OF SILICON ON THE CORROSION OF CAST IRON.*

*By J. Newton Friend and C. W. Marshall (Worcester).

Owing to its relatively low melting point, the ease with which objects may be cast from it, and their extreme hardness when completed, cast iron is now being used for commercial purposes in ever-increasing quantities. It is eminently desirable, therefore, in view of the serious nature of the corroding influences to which articles are exposed, to determine what the influence of varying constituents may be on the corrodibility of cast iron, and to learn what particular compositions offer the maximum resistance to corrosion.

Hitherto but little work has been done in this connection, which affords a wide field for research, inasmuch as the chemical composition of cast iron and the physical conditions at the time of experiment, admit of enormous variation. The problems are in consequence proportionately complicated, and a vast amount of work remains to be done before generalizations of any real value can be made. In the present paper the authors give the results of a study of the influence of silicon upon the corrodibility of cast iron.

For many years chemists have recognized that the presence of alloyed silicon tends to retard the corrosion of iron. Thus Mallett† more than seventy years ago was aware that cast iron rich in silicon is less readily attacked by acids, and Jouve‡ has recently proved that alloys of silicon and iron containing 20 per cent. of the former element are remarkably resistant to acid attack. But alloys such as these are not cast iron, and their utility is greatly restricted by the difficulty of working them on account of the peculiar properties imparted to them by the silicon.

The authors have therefore confined their attention to the influence of corrodibility exerted by a silicon content varying from 1.24 to 2.28 per cent. They would gladly have extended this series had it been possible, but the advantage of studying this particular range is twofold:—(1) It covers many of the various silicon contents usually met with in commercial cast irons and the results are not therefore of purely scientific interest. (2) The silicon is never so great as to interfere with the nature of the carbon content.

The latter is a most important point, and one to which we hope it may be possible to give further attention at a later date. As is well known, the presence of silicon tends to throw out the carbon as graphite, thereby rendering the metal porous and more liable to corrosion. Consequently, unless particular care be taken to keep the carbon in the same condition, both physically and chemically, the influence of the silicon per se upon the corrodibility of the metal must be affected by the proportion of graphitic carbon, and the results rendered misleading. The various cast irons used in this research were especially prepared for the authors by Messrs. Green and Company, of Wakefield, and they have pleasure in acknowledging their indebtedness to the manager, Mr. W. B. Greener, for his kindness. The irons were cut into blocks measuring 4.8 x 1.1 x 1.5 cubic centimetres, and, after rubbing with emery paper, were tested in this form. The authors wish also to thank Mr. A. E. Page, chemist to Messrs. Green and Company, for kindly analysing the metals for them. The results of these analyses were as in Table I.:—

TABLE I.

Cast iron No.	Percentage of Composition. Silicon.	Graphite.	Combined carbon.	Manganese.	Sulphur.	Phosphorus.
1	1.24	2.70	0.65	0.63	0.096	0.99
2	1.20	2.65	0.68	0.75	0.093	1.05
3	1.45	2.55	0.65	0.89	0.082	1.04
4	1.55	2.70	0.67	0.86	0.079	1.02
5	1.72	2.75	0.61	0.75	0.085	1.06
6	2.04	2.60	0.51	0.86	0.115	1.09
7	2.28	2.75	0.55	0.69	0.076	1.04

It will be observed that, with the exception of the silicon, the other elements are present in the cast iron in remarkably uniform proportions. The corrosion of the samples containing the lowest quantity of silicon (No. 1) is in all the accompanying series taken as 100, the corrodibilities of the other samples being expressed accordingly.

I.—Tap Water Tests.—The samples of iron were laid on sheets of paraffin wax in glass beakers containing 500 cubic centimetres of tap water. After seventeen weeks the irons were removed, carefully scraped free from rust, rinsed in alcohol, and dried in a steam oven. They were then weighed, the loss in weight being taken as a measure of the corrosion (see Table II.).

*Paper read before the Iron and Steel Institute, May 1st, 1913.

†British Association Reports, 1838, p. 277.

‡Journal of the Iron and Steel Institute, 1908, No. III., p. 310.

TABLE II.—Corrosion of Cast Iron in Tap Water (17 Weeks' Exposure).

Cast iron No.	Silicon. Per cent.	Original weight. Grammes.	Loss in weight. Grammes.	Corrosion factor.
1	1.24	57.0494	0.4040	100
2	1.29	57.3176	0.3276	81
3	1.45	57.6996	0.4098	101
4	1.55	54.5786	0.4028	100
5	1.72	56.9500	0.3980	99
6	2.04	59.4522	0.3846	95
7	2.28	57.6416	0.3554	88

II.—Salt Water Tests.—These experiments were carried out in a precisely similar manner to the preceding ones, save that the liquid corrosive medium was 3 per cent. salt solution (see Table III.).

TABLE III.—Corrosion of Cast Iron in 3 per cent. Sodium Chloride Solution (13 Weeks' Exposure).

Cast iron No.	Silicon. Per cent.	Original weight. Grammes.	Loss in weight. Grammes.	Corrosion factor.
1	1.24	57.0036	0.3134	100
2	1.29	57.3356	0.2882	92
3	1.45	57.6354	0.2974	95
4	1.55	54.9200	0.3112	99
5	1.72	57.2766	0.3182	101
6	2.04	58.5736	0.3172	101
7	2.28	58.5102	0.2758	88

III.—Alternate Wet and Dry Tests.—These experiments were carried out in a precisely similar manner to those detailed in connection with nickel and chromium steels.* The results were as in Table IV.

TABLE IV.—Corrosion of Cast Iron exposed to Alternate Wet and Dry (15 Weeks' Exposure).

Cast iron No.	Silicon. Per cent.	Original weight. Grammes.	Loss in weight. Grammes.	Corrosion factor.
1	1.24	56.0926	1.0442	100
2	1.29	56.6978	1.2116	110
3	1.45	58.2680	1.0780	103
4	1.55	55.4664	1.0424	100
5	1.72	57.2854	1.0370	99
6	2.04	58.5464	1.0738	103
7	2.28	57.5996	1.0996	105

IV.—Sulphuric Acid Tests (0.05 per cent.).—These experiments were carried out in a precisely similar manner to those with tap water, the corroding liquid in this case being 0.05 per cent. sulphuric acid—that is, 0.5 gramme of acid in 1,000 grammes of solution with water. The acid was renewed every fourteen days. The results were as in Table V.

TABLE V.—Corrosion of Cast Iron in 0.05 per cent. Sulphuric Acid (13 Weeks' Exposure).

Cast iron No.	Silicon. Per cent.	Original weight. Grammes.	Loss in weight. Grammes.	Corrosion factor.
1	1.24	56.6814	0.5962	100
2	1.29	56.3498	0.6258	105
3	1.45	57.8794	0.5938	100
4	1.55	55.9416	0.5826	98
5	1.72	56.9324	0.6192	104
6	2.04	58.4756	0.6182	104
7	2.28	56.8700	0.6000	101

*Journal of the Iron and Steel Institute, 1912, No. I., p. 249 (See Iron and Coal Trades Review, May 10, 1912).

V.—Sulphuric Acid Tests (0.5 per cent.).—These experiments were similar to the preceding, save that stronger acid was employed, which was renewed every fourteen days (see Table VI.).

TABLE VI.—Corrosion of Cast Iron in 0.5 per cent. Sulphuric Acid (13 Weeks' Exposure).

Cast iron No.	Silicon. Per cent.	Original weight. Grammes.	Loss in weight. Grammes.	Corrosion factor.
1	1.24	56.9196	5.4512	100
2	1.29	56.6360	5.4486	100
3	1.45	57.9528	5.3868	99
4	1.55	55.4094	5.4218	99
5	1.72	56.7000	5.5454	102
6	2.04	58.6396	5.7658	106
7	2.28	57.6414	5.7614	106

Discussion of the Results.—For the sake of facilitating the discussion of these results, Table VII. has been drawn up, in which the corrosion factors of the cast irons as obtained in the present research are grouped together.

TABLE VII.

Cast iron No.	Silicon. Per cent.	Corrosion factor in Tap water.	Wet and dry.	Salt water.	0.05 per cent. acid.	Mean factor.	Corrosion factor in 0.5 per cent. acid.
1	1.24	100	100	100	100	100	100
2	1.29	81	116	92	105	98	100
3	1.45	101	103	95	100	100	99
4	1.55	100	100	99	98	100	99
5	1.72	99	99	101	104	101	102
6	2.04	95	103	101	104	101	106
7	2.28	88	105	88	101	96	106

A study of Table VII. reveals the following interesting facts:—(1) The corrosion factors for the irons in acids and neutral media are almost identical. This is very remarkable in view of the divergence usually observed between the two in the case of steels. (2) All the irons corrode at a uniform rate, although No. 7 shows a slight tendency to corrode less rapidly in neutral solution. Possibly this indicates that if the percentage of silicon were raised still higher, without affecting the proportions of graphitic and combined carbon, a gradual increase in resistance to corrosion would be observed. We may safely conclude, however, that a variation in the percentage of silicon between the limits of 1.2 and 2.3 per cent. has no appreciable influence per se upon the corrodibility of the cast iron. If the relative proportions of graphitic and combined carbon are simultaneously varied with the silicon, a considerable difference in the corrodibility may be expected, and this is a point upon which the authors hope to throw further light at a future date.

PROSPERITY OF THE BRITISH SHIPBUILDING TRADE.

During the early part of this year British shipbuilding firms had in hand the construction of 563 vessels with an aggregate of 2,063,694 tons. This exceeded by 377,000 tons the vessels on hand last year, and makes the highest record in the history of the British shipbuilding trade.

The tonnage of vessels at present under construction in British shipbuilding yards is equal to two-thirds the entire mercantile marine of Germany, and is about double the entire mercantile marine of France.

WELDING BY THE ELECTRIC ARC.

By J. F. Lincoln.

An arc welder is essentially an apparatus for transforming electric current at high voltage to a low voltage work current with heavy amperage. In a paper read before the American Foundrymen's Association recently, Mr. J. F. Lincoln described briefly a number of types of welder that have more or less satisfactorily established a place for themselves in commercial use.

The changing of the current which is necessary for the best application of the arc is first the reduction of the voltage to a value somewhere between 30 and 60 and then some kind of arrangement so that this voltage will be reduced as the current increases. In other words, as the resistance of the arc decreases on account of increasing current, the amount of current that flows must not increase to a point which will burn the weld or give varying results. That is, the welder must have a dropping characteristic so that as the current flow increases the voltage will drop, and drop considerably.

The first types of arc welder were of resistance units, either a water rheostat or grid resistance which placed sufficient resistance in the circuit so as to reduce the voltage to the proper point for use in the arc. This is a very satisfactory method for arc welding and the only disadvantage is that about 65 per cent. of a 110-volt current and 85 per cent. of a 220-volt current is wasted in the resistance. Another bad feature is the fact that it is rather difficult to handle large currents through resistance in a satisfactory manner on account of the burning-out of the resistance units.

Another type consisted of a motor-generator set, the only possible advantage of which over the resistance method being some current saving. There are many devices of this kind which give a satisfactory arc and save some of the current which was lost in the resistance type. With the motor-generator set it is necessary to keep a considerable amount of resistance in circuit in order to act as a ballast, or to limit the amount of current when only a small amount is required.

The usual application of the electric arc in welding is made by forming an arc between a carbon electrode and the piece to be welded. Since the piece which is welded is the positive electrode, practically all the heat of the arc is liberated here, very little being released at the negative carbon electrode. Into this arc is passed the filling metal which rapidly melts off and drops on to the positive electrode, kept at a welding temperature by the arc. In this way a weld which is perfect can be made because both the filler and the piece to be welded can be kept at a temperature at which the metal is fluid; 95 per cent. of all arc welding is done in this way.

There is another application for the electric arc, however, which is used to some extent in certain classes of work where the weld must be made overhead or on the side of a piece into which the molten metal cannot be dropped. For this application an electrode of metal is used, this electrode itself being the filler. As the arc is established the metal electrode slowly melts off, sticking on to the part already heated by the arc.

This metal electrode work is apt to be unsatisfactory unless carefully done, on account of the fact that the metal welded on must be heated to a welding temperature and the point it touches must also be heated to the same temperature.

In a general way, the statement is true that the weld is equally as strong as the original piece, providing that the original piece is of the same quality and kind of metal as the filler used. This statement, however, does not fully comprehend the difficulties in the way of getting a weld which is as strong as the original piece. A steel casting can be repaired by the use of the arc welder and a weld can be made the strength of which will exceed 60,000 lbs., which is as strong as the average steel casting. The strength of the weld is practically constant when properly made and is approximately 60,000 lbs. per sq, in. Whether it is stronger or weaker than the original piece depends on the strength of the section.

In the cutting of steel, the electric arc has another application. It is used extensively for cutting sheets, boiler-plate, etc. This work can be done cheaply and efficiently when compared with punch press, cold saw, or any other method of cutting.

MODERN METHODS IN THE MANUFACTURE OF PORTLAND CEMENT.

By Mr. H. K. G. Bamber,
Assoc. Inst. C.E., F.C.S., M.C.I., Etc.

The subject matter of this paper has had the close attention of the engineering profession during recent years, in view of the important functions which this material exercises in almost all constructional work. More especially is this the case where the engineer has to combat the mighty forces of nature, which are continually acting on such constructions, more particularly in connection with hydraulic and marine work, such as docks, harbors, breakwaters, water reservoirs, etc., where the combination of forces is such that only the most skilful design, coupled with the use of the highest quality of the most suitable material, can insure success.

To the engineering profession is largely due the credit for the improvement in the quality and adaptability of the material which is the subject of our discussion. By collaboration of their varied experiences in the use of Portland cement, aided by the technical knowledge of the manufacturers, improvements have been introducd into manufacturing processes, which have wholly, or almost entirely, removed the defects which existed in the early days of the manufacture.

Specifications have been drafted as the result of the combined experiences of engineers in all branches of the profession, which have gone far to raise the standard of quality, and to insure uniformity of this most important material of construction.

The general principles governing the manufacture of Portland cement are well known to the profession. It will therefore only be necessary to refer shortly to the usual methods of manufacture, devoting the space at our disposal more particularly to those processes upon the proper conduct of which depends the ultimate quality and reliability of the material produced.

Need of Uniformity in Quality.—Portland cement is now being manufactured in all parts of the world from a variety of raw materials all having as their base some form of calcium carbonate, which, together with suitable argilaceous materials, form the principal ingredients of manufacture. These materials must be perfectly amalgamated and combined chemically in fixed and defiant proportions, the limits of which are not so wide as is generally supposed. Nature

* Notes on a paper delivered to the Canadian Society of Civil Engineers, Vancouver Branch, on May 26th, 1913.

has, in some localities, partially prepared and amalgamated these raw materials, but apparently without any pre-conceived ideas as to the use which such material might ultimately be put, or the stringent requirements of engineers' specifications, with the result that in localities where such partially mixed materials are found, too much reliance is sometimes placed on these ancient natural operations, with the result that cement manufactured therefrom usually has a reputation noted for the variety of its characteristics, and frequently contains one of the principal elements of failure, i.e., want of uniformity. Unless such pseudo-natural raw materials are dealt with on scientific lines, it is preferable that the material operated upon should exist in their elementary condition, having a fixed, definite, and uniform chemical composition, such as pure calcium carbonate, the line in which constitutes the base of the finished material, and clay or shales containing the acid constituents in correct ratio. Given modern machinery for the proper proportioning, amalgamating, and calcining of such materials, and the subsequent reduction, to a fine powder, of the resulting clinkers, a more uniform product can be obtained than by the use of semi-natural materials, where too much reliance is placed upon the reducing and mixing effects of ancient geological operations.

The manufacture of Portland cement has its origin in Great Britain, where suitable materials are found in the greatest abundance. The advancement of chemical science, however, has enabled materials of different characteristics found in various parts of the world to be brought into use. The author has been engaged in British Columbia on the construction of a cement plant at Bamberton on the Saanich Inlet, Vancouver Island, for the Associated Cement Company (Canada) Limited, a company formed by the Associated Portland Cement Manufacturers, (1900) Limited, of England, to operate upon a practically pure limestone, and a clay shale of very uniform composition. With these materials, and with the aid of the modern plant which has been installed, it is confidently expected that cement will be produced of a quality equal, if not superior, to the cement imported from the United Kingdom, the utmost importance being placed on the great desideratum of all engineers, i.e., uniformity of quality.

While describing, with the aid of lantern slides, the general methods of manufacture usually adopted, particular reference was here made by Mr. Bamber to the special additional processes which have been introduced in the new plant at Saanich Inlet, in order to insure the absolute uniformity of quality, the absence of which in the product of many plants has been the cause of much anxiety and trouble to the constructional engineer.

Uniformity in Setting.—There are many factors which help to produce various unsatisfactory results, but perhaps the feature of most importance in the experience of the engineer, and the one in which uniformity is most desirable, is that of setting time. The difficulties of the engineer are great, if during the construction of some important work he is suddenly confronted by a change in the characteristics of the materials he is using, to counteract which might necessitate a reconsideration of his methods of construction, and it should be the aim of all cement manufacturers to supply as uniform a material as possible; so regulating the various properties of their product to suit the climatic and other existing conditions which have a most important bearing on the setting time of all cement which as a chemical product is rapidly affected by changes in atmospheric conditions. The difficulties which confront the cement manufacturer who, having produced an article, the very first quality of which is subject to variation in many of its characteristics due to such atmospheric changes, is not fully realized or understood, and it frequently happens when some difficulty arises in connection with construction, due to such causes, the quality of the cement is unjustly impugned. Long experience has taught the prudent manufacturer how to produce cement which is least affected by such changes, and the methods adopted will be shortly described.

The manufacture of Portland cement necessitates three distinct and separate operations. The first process is mechanical, and includes the assembling, proportioning, amalgamating and grinding the raw materials; the second chemical, during which the material prepared by the first process is calcined at a high temperature, bringing about chemical combination of the various ingredients; the third and final process being partly mechanical and partly chemical, in which the clinker resulting from the calcining operation, together with a small percentage of retarder, is reduced to a fine powder. During the latter operation the cement is submitted to a partial process of hydration by means of steam, at a temperature ranging between 220° and 300° F., and after subsequent cooling the cement is ready for immediate use.

Mechanical Process.—It is essential that the raw materials selected are of such physical character as to be easy of reduction, and such chemical composition that the resulting mixture contains the necessary ingredients in proper ratio, one to the other. If so constituted, and thus available for the purpose, the proportions of the mixture are kept constant by means of continuous chemical supervision, the permissible limits of variation in the composition of the raw mixture being very narrow.

This preliminary part of the manufacture may be conducted by one of three methods, the selection depending upon the physical condition of the raw material to be operated upon.

Where the materials are soft, as in the case of chalk, clay and marls, such as are found in England, the wet process is usually adopted, which consists of reducing the materials together to a pulp, or slurry, containing about 40% water. This is easily accomplished in open wash mills, or pug mills, requiring but small expenditure of power.

When one or both of the materials are of a hard or crystaline character, and in some cases with the soft materials already referred to, the dry process is adopted, which consists of evaporating the water from the raw materials as quarried, and grinding them in a dry state to a fine powder, by means of suitable machinery.

The third process, which is suitable for both soft and refractory materials, has been adopted for the works at Bamberton, Saanich Inlet, and consists of a semi-wet process, in which the drying of the raw materials is avoided—the materials being reduced to a thick slurry in mills suitable also for the dry process, but with a small percentage of water, producing a more uniform and reliable product than is possible with the dry process.

In any of the processes it is essential to reduce the raw material to such fineness that at least 95% will pass through a sieve having 32,400 holes per square inch, more particularly where the materials have not been partially mixed by nature.

A great improvement in the quality of the cement is produced by the introduction at this stage of the manufacture, of such storage capacity and machinery that large quantities of this prepared slurry can be kept in reserve, and continuously mixed, thus correcting any irregularities that may have occurred in the composition of the material during the first mixing and grinding operations. By this means a product

of absolutely correct and uniform composition is presented to the kiln for calcination, and it will be readily understood that, although the cement industry as a whole has not until recently thought it necessary to provide such intermediate storage of prepared raw material, how important it is, before the material is submitted to an expensive chemical process of calculation, in which the desired results are so adversely affected by any irregularity, either in the material or the temperature at which the operation is conducted, that this correcting process should be installed. It is not possible to get perfect chemical combination of the lime with the silicates and aluminates of the clay or shale unless the materials have been reduced to a very fine state of subdivision, and have been thoroughly amalgamated.

Chemical Process.—The calcining or clinkering is carried out in rotary kilns, which with modern practice are increasing in size, now averaging from 150 to 200 feet in length, and from 7 to 10 feet in diameter, being set at an angle to the horizontal of ½ inch to the foot. The raw material is fed into the upper end of the revolving kiln, while the fuel for raising the temperature within the kiln is introduced at the lower end, the raw material passing successively through the three operations of drying, calcining, and clinkering, on its passage down the kiln, the clinker leaving the kiln at red heat. This heat is removed by passing it through rotary coolers, and is used for heating the air for combustion passing into the kiln.

The cool clinker is now ready for the final grinding operation, but before being submitted to this the clinker is stored and mixed under cover in large bulk, so that again any small irregularities of the calcining operations are spread over the product of several days, and thus tend towards uniformity of the finished product.

Final Process.—After cooling and mixing, the clinker, which is material of hard and refractory character, is reduced to a fine powder with the aid of very powerful crushing and grinding machinery, details of which will be explained with the aid of lantern slides. The importance of very fine grinding was not realized until recent years, but its value will be understood when it is known that it is only the impalpable powder of the cement which has any cementituous properties—the coarser particles present being of no more value than their equivalent bulk of sand or crushed rock. It is common practice at the present time to so reduce the clinker that 85% will pass through a sieve having 32,400 holes per square inch, but at the new works at Bamberton, machinery has been installed to enable the cement to be so ground that 95% will pass through this sieve if required. This extra fineness materially increases the cost of production, but adds considerably to the cementituous value of the material. Using this fine ground cement a much richer and stronger concrete is obtained, by reason of the larger quantity of cementituous material present in the very finely ground cement, or on the other hand economies in cost of construction can be obtained by reason of the larger amount of aggregate which such fine ground cement will carry, to produce equal results.

During the process of grinding provision is made for the regulation of the setting time of the cement. Cement clinker ground without any such provision is always very quick setting. The method adopted at the Bamberton works is similar to that now almost universally employed in England, and consists of injecting steam into the tube mills during the final process of grinding together with the addition of a much reduced proportion of gypsum, which is used as a retarder. The effect of this process is to hydrate and thus remove the expansive properties of any loosely combined lime compounds which have resulted from any slight defects which have passed the earlier processes uncorrected, and thus produce a cement which is safe to use immediately after manufacture, even if taken hot from the mill, and by means of this process the setting time of cement can be regulated to suit all requirements.

Extraction of Heat.—The difficulty often experienced by engineers, however, in using hot cement is being provided against by the introduction, at the Bamberton works, of a separate cooling plant, through which all cement as it leaves the grinding mill is passed. This special plant extracts the heat from the cement, reducing it to atmospheric temperature before storage. This is a very important addition to the methods of modern manufacture and, although used largely in Euglish plants, is being introduced for the first time into Canada, or indeed on the American continent, at the plant now being installed. After the cement has been submitted to the process described, it is stored, and mixed in large bulk at atmospheric temperature, before being placed on the market, and it is hoped that the provision which has been made at the new works to produce cement of absolutely uniform quality, will be appreciated by engineers and contractors throughout the western provinces of Canada.

The works at Bamberton are now just commencing manufacturing operations, and will be producing full output of 2,000 barrels per day before the end of June. The works were designed by the Associated Cement Company's own staff, and practically the whole of the machinery was manufactured in England. The work of construction was entrusted to Messrs. McAlpine, Robertson & Company, of Vancouver, under the supervision of the Associated Company's resident engineer's staff; the power for the plant being supplied by the British Columbia Electric Railway Company.

The lecture was illustrated by many interesting pictures of the machinery and plant used in the process of manufacture, all of which were most successfully explained by the lecturer.

PROPOSED FLOATING DOCK FOR VALENCIA, SPAIN.

The contract having been awarded for completing the harbor works of the port of Valencia, the Board of Harbor Works is now giving attention to the matter of docking facilities for the cleaning and repair of vessels, says the United States Consul at Valencia. About three months ago the board proposed to the Government the erection of a small shipyard to accommodate vessels of less than 300 tons. The latest project is a floating dock for handling sea-going ships up to 3,500 tons displacment. Harbor space is too limited to permit of a large dock at this time, according to the system employed at Kiel, Hamburg, Cardiff, Genoa, Barcelona, etc. The tentative plans, therefore, propose the construction on a smaller scale according to the most approved system, but in such a manner as to later permit it to be dismounted and used as a constituent part of the proposed floating dock of 8,000 tons capacity provided for in the approved scheme of port facilities. The details and specifications of the work have not been published, but the preliminary project as submitted to the Ministry of Fomento calls for an expenditure of about £55,000, the dock to be completed in two years. It is hoped that the plans will be speedily approved by the Government, in order to call for bids and award the contract. Engineers and others desiring to learn more about this project can address the Director de la Junta de Obras del Puerto, Sr. Don José Marie Fuster, Valencia.

THE FLAT SLAB SYSTEM IN FLOOR CONSTRUCTION

NOTES DESCRIPTIVE OF ADVANCES IN REINFORCED CONCRETE FLOORS IN PAST DECADE—COMPARISON WITH BEAM AND GIRDER SYSTEM — BEHAVIOR UNDER LOAD

By W. G. URE, B.A.Sc.

THE flat slab system of reinforced concrete floor construction may be defined as that system in which the load is carried from the slab directly into the columns without the use of floor girders or beams, the columns usually being built with a wide flaring top. One of the earliest engineers to make use of this system was Mr. C. A. P. Turner, of Minneapolis, Minn., who first described it in "The Engineering News" October 12th, 1905. In the course of his practice Mr. Turner had found that long span slabs were much more economical in general than those of shorter span and, after building panels up to 24 feet in span, he began to wonder if it were necessary to put in any ribs at all. He investigated the question thoroughly and developed a system of flat slab construction which he called the "mushroom" system. The word "mushroom" is his patented trade-mark, and in using this word to designate flat slabs other than those designed by him, an incorrect use of the term is made. Mr. Turner's patent covers the peculiar arrangement of steel over the column head used in his system, and shown in Fig. 1.

The principle of eliminating all beams and girders was also taken up by other parties, and several other patents taken out regarding it. Probably the first building to be constructed with this type of floor was at the plant of Proctor and Gamble, Armourdale, Kansas, which was built in 1903 from the designs of L. J. Mensch.

The owners and occupants of buildings were quick to appreciate the many advantages which this form of construction possesses, as compared to the beam and girder system. It has come into extensive use, and seems likely to largely supplant the older type, especially in such buildings as warehouses where very heavy floor loads must be provided for.

Since all loads are carried directly to the columns, all reinforcing metal must centre there. The steel is laid in bands about seven-sixteenths of the span in width, a band running along each side of the panel, and one along each of the diagonals. Thus each column has four continuous bands of steel passing over it. Fig. 1 shows the arrangement of the bands. Since the slabs are considered continuous over the supports the metal will lie at the bottom of the slab in the centre of the panel and in the upper part of the slab over the column. The steel passing over the column head is supported on a steel frame which holds the bars in place, takes some direct tension in the top of the slab, and aids in conveying the stresses to the columns. The latter are commonly built with a wide, flaring head in order to keep the shearing stresses down to the permissible values. The structure has been likened to an umbrella at each column, with the rest of the floor suspended from the edges of the umbrellas.

In comparing the flat slab system with the ordinary beam and girder system, the most obvious advantage of the former is the total elimination of projecting ribs below the bottom of the floor slab. Besides being a distinct improvement from the æsthetic point of view this permits a better distribution of light. In any building the light which is reflected from the ceiling is an important consideration. Figs. 2 and 3 show graphically how projecting ribs interfere with this reflection and the even distribution of light obtained with the flat slab system.

It also greatly simplifies the erection of shafting, as there is no interference by beams or girders. In the installation of sprinkler systems great economy results. There is nothing to prevent the water from spreading out evenly in all directions, and whereas it is often necessary to run a line of sprinkler heads down each side of a deep girder, one line would serve the same purpose if the girder be dispensed with.

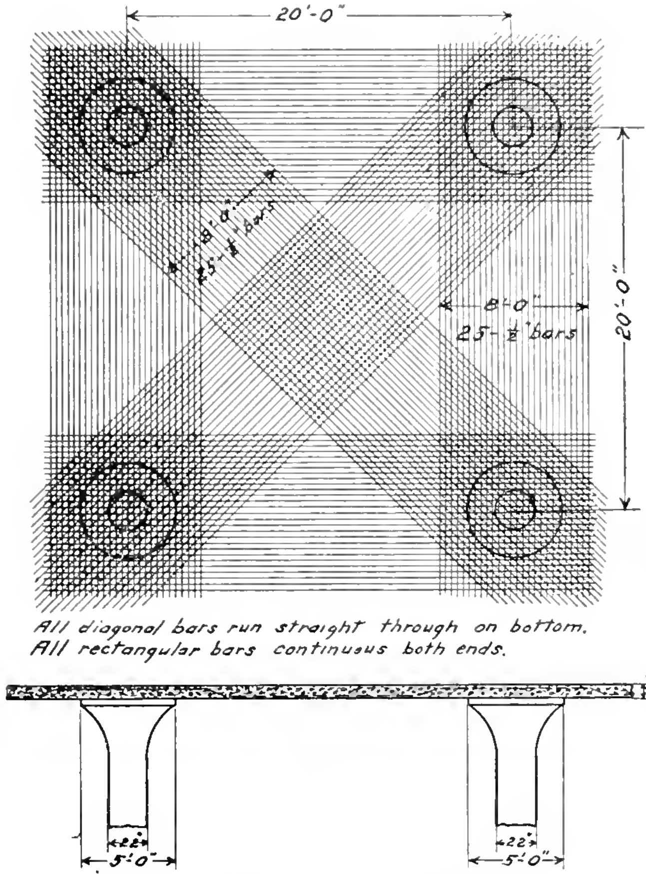


Fig. 1.—Typical Floor Reinforcement.

The height of any building required to obtain a given clear story height is reduced with a corresponding reduction in the cost. For instance, a building for the Toledo Lamp Works was originally designed for a beam and girder system with a 5-inch floor slab, 13-inch x 29-inch longitudinal girders and 10-inch x 23-inch transverse beams at 10-foot centres. The flat slab system finally adopted provided for a floor slab of a uniform thickness of 7 inches. This reduced the story height by 22 inches, which in a four-story building amounted to 88 inches, or more than seven feet. It was estimated that this change in plan meant a saving of from six to seven cents per square foot of floor area. Again, in the Grellet-Collins

building, Philadelphia, the total thickness through the floor was seventeen inches less with the mushroom system than with the beam and girder system. Mr. Turner claims that for a given clear story height it effects an economy of about 10 per cent. of the material in the vertical walls.

In the matter of speed and ease of erection the flat slab is much superior to any other type. The centering is simple and easy, there being no beams to build around. There is no bother with stirrups, and is it claimed that it is easier to make a good bond between old work and new because the concrete is not so deep and the inert material known as laitance does not accumulate to so great an extent.

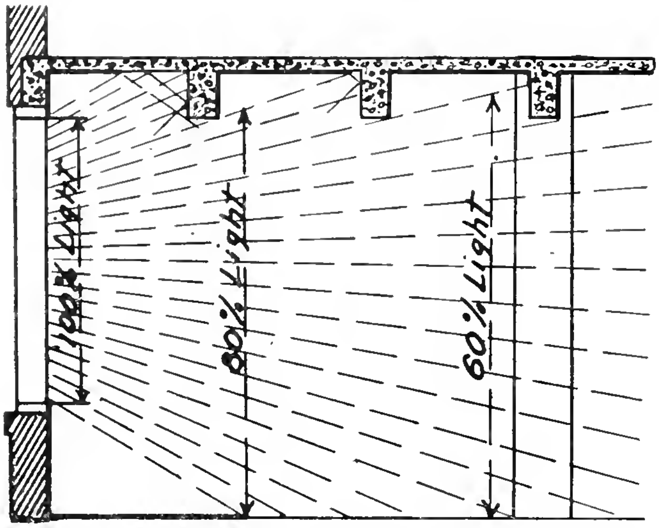


Fig. 2.—Beam and Girder System. Light Rays Reflected by Ceiling are Pocketed by Beams.

Maximum efficiency in reinforcement is attained as the stresses go direct to the columns, not having to be carried round a corner, so to speak. The greatest quantity of metal is over the column head where moment and shear are both a maximum. The concrete is being worked in several directions by the multiple way reinforcement, the distortion in one direction tending to offset and counterbalance that in the other. The metal runs so many ways over the support that the whole structure is tied together, and no failure can occur without adequate warning being first given. The fact that the concrete is concentrated in the slab and that the stresses due to any concentrated load are carried in so many different directions tend to produce rigidity, and to reduce the heavy vibration caused by the working of printing presses and like machinery.

The cost of forms is reduced owing to their simplicity and the fact that they can be so designed that they can be used over and over again without material alteration. In a warehouse built for the Terminal Wharf and Warehouse Company, of Boston, the forms were designed in the draughting room and shipped complete to the site. Since then they have been used in another building. Each panel was erected and removed fifteen times and some twenty, and at the end of that time were still serviceable.

In another instance, assuming the material delivered at the site on cars, and that form lumber could be used twice, the following results were obtained for the cost of forms:—

Floors with beams, girders and slabs..	10 cents per sq. ft.
Slab floor without beams	7 cents per sq. ft.

As to economy, it is claimed that the amount of material required to build a slab or panel that will carry a given test load is less than with any other type. This economy increases rapidly as the load to be carried increases, since the strength of the slab increases approximately with the square of the depth, and hence the relative increase in cost for a given increase in the capacity of the construction is small. In this connection it is well to remember that these floors are considered by many engineers to be lighter, and hence cheaper, than is good practice. However, a reputation has been built for them on their ability to successfully withstand very heavy test loads.

In a paper entitled "The Economical Design of a Reinforced Concrete Floor Panel," Mr. J. Norman Jensen gives cost data for a typical floor panel twenty feet square designed in fourteen different ways. He concludes that of all the designs the flat slab appears to be the most economical. His slab was heavier than Mr. Turner's, being designed by a method requiring considerably more steel. His figures for four of these systems, as illustrated in Fig. 4, accompanying the diagrams, and show a decided economy in the use of the flat slab system, it being 15 per cent. cheaper than its nearest competitor.

In common with everything else, however, the flat slab system has certain disadvantages. The greatest of these is undoubtedly the fact that no adequate theoretical analysis of the stresses in such a floor has ever been put forward, and in consequence there is great uncertainty as to the exact stress distribution within the slab. While this is true it must be admitted that, even at this early stage in its development, it is perfectly feasible to design a flat slab floor and guarantee its safety under the design load, and still maintain a good margin of economy over the earlier types.

Again, the fireproof qualities of the construction have been questioned as the main steel reinforcement in the panel is only protected in most cases by from ¾ inch to 1 inch of concrete on the bottom, a thickness quite inadequate to properly protect the steel in a severe conflagration. Also in a shallow slab of this sort an error in placing the reinforcement is liable to produce more serious results than in a comparatively deep beam or girder. On account of its greater deflection and the flaring column head the flat slab type of

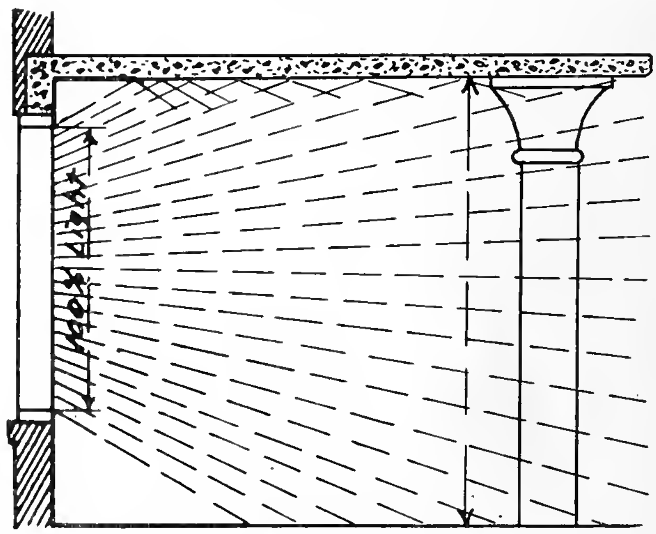


Fig. 3.—Flat Slab System. Light Rays Reflected from Ceiling Give an Even Distribution.

floor is more apt to set up excessive bending stresses in the columns than is the ordinary floor designed in the beam and girder system. Care in the design and in the placing of the steel will minimize these disadvantages.

The Behavior of a Flat Slab Under Load.—It is interesting to consider the manner in which the slab in such a sys-

tem deflects under load, and the nature of the stresses set up by such deflection. Since our knowledge of these stresses is to a large extent based on experimental data, it will be well to describe as briefly as possible a few of the experiments which have been conducted for this purpose.

For a panel square or nearly so it is evident that the face of the slab tends to become a warped surface, assuming continuity over the columns and that the adjacent panels are also loaded. In other words, the slab assumes a dome shape over the column, and a bowl or dish shape in the central portion of the panel. There must then be a line of inflection passing around the column head and dividing off these two regions.

Assuming the slab to be uniformly loaded over its whole area, that part of the slab over the column head may be regarded as an inverted footing supporting a single concentrated load on an area at the centre equal in size and shape to the column capital. The central portion, on the other hand, is like a plate of roughly circular shape supported around the circumference and carrying a uniformly distributed load.

The main stresses would then be in the portion over the column head tension at the upper surface and compression at the lower surface, and in the central portion compression at the upper surface and tension at the lower surface. So, taking a strip of unit width from one column to another, the nature of the stresses would be similar to those in a beam restrained at both ends, and to resist these stresses the steel would be placed as shown in Fig. 1. On account of this restraint it is evident that the columns must be so proportioned that they can resist the bending stresses set up by an eccentric loading such as would occur with one only of several adjacent panels loaded.

Again, a point midway between columns along a line diagonal to the panel will obviously deflect more than a point midway between columns along the side of the panel. This would give rise to tension in the upper part and compression in the lower part of the slab along the side of the panel and in a direction perpendicular to it. These stresses are, of course, of only secondary importance, and the usual method of laying the reinforcement does not make any special provision for them. Cracks along this line, however, formed in numerous multiple panel tests on flat slabs, and even in some cases formed under the dead weight alone, are practical evidence of the existence of this tension.

The Corrugated Bar Company, of Buffalo, have developed a two-way system of reinforcing flat slab floors as distinguished from the usual four-way system, and have adopted the trade-name "Corr-Plate Floors." In this system the diagonal bands of steel are omitted, the entire slab being reinforced by steel placed parallel to the sides of the panel in both directions. One of the advantages claimed for this system is that these tensile stresses can easily be provided for, but as far as the author's knowledge goes it has not come into very extensive use as yet.

It is also probable that in the portion of the slab over the column there are compressive stresses set up along lines roughly parallel to the line of inflection and concentric with the columns due to the doming action; and also similar compressive stresses in the central portion due to the dishing action. These stresses are, of course, taken up by the concrete.

Shear in the flat slab is of two kinds; punching shear, and shear which indicates a tendency towards diagonal tension. The punching shear is a maximum at the outer edge of the column capital, and is due to the capital trying to "punch" a hole through the slab. The diagonal tension has its greatest intensity a short distance out from the column capital.

With regard to moments, the maximum moment occurs over the column, not at the centre of the slab, the critical section being at or near the edge of the capital. The moment coefficient by which to multiply the product of the load and the length, similar to the coefficient "one-eighth" in beams uniformly loaded and freely supported, has not been satisfactorily determined. As a result there are a great variety of moment factors being used. The question of shears and moments will be considered at greater detail elsewhere.

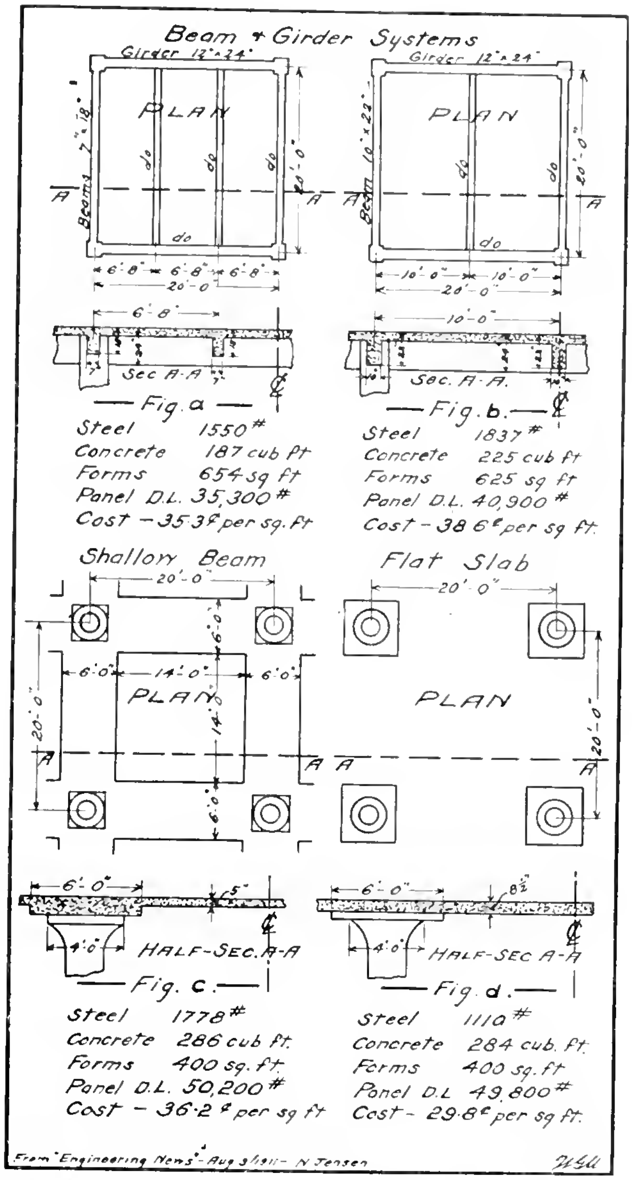


Fig. 4.—Four of Jensen's Fourteen Flat Slab Systems.

Mr. Arthur R. Lord, Research Fellow in the Engineering Experiment Station, University of Illinois, describes in detail a test made by him on a flat slab floor in the proceedings of the National Association of Cement Users, 1911. He describes it as an attempt to carry out a test on a floor in a building constructed under actual working conditions with some of the refinement that can be attained in laboratory testing. The test was made on the fourth floor of an eleven-story warehouse in Minneapolis. The floor was designed for a live load of 225 pounds per square foot, and was of 1:2:4 concrete 9 3/16 inches thick. The panel was 18 feet 8 inches

by 19 feet 1 inch, and was forty days old when tested. Fig. 5 shows the manner of reinforcing.

The deformations in the steel and the concrete at the critical points were obtained by means of extensometers, and from the data thus obtained the various stresses were computed. Mr. Lord claims that the precision attained in his measurements was such that the stresses in the steel were obtained with a maximum error of 1,000 pounds per square inch, and in the concrete with a maximum error of 50 pounds per square inch.

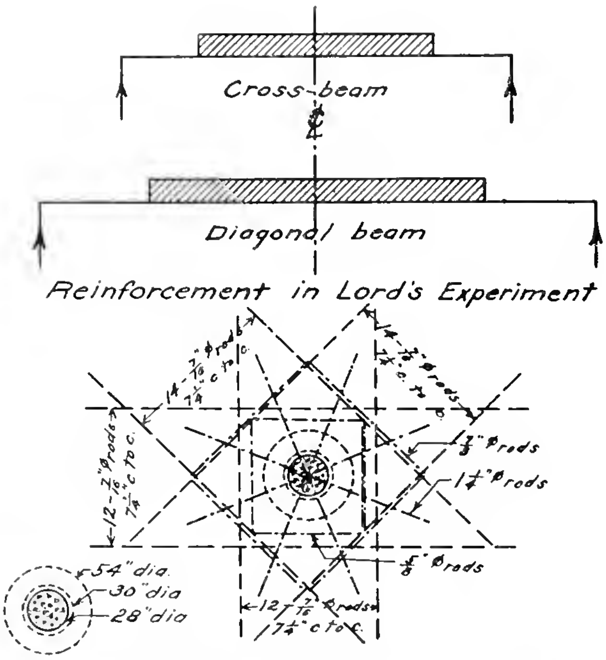


Fig. 5.—Column Used in Lord's Test, Showing Reinforcing.

With regard to deflection it was found that the presence of joints where new concrete is joined to old materially increases the deflection. For eight panels loaded the deflection in the centre panel was 1/1400 of the span, and for one panel only loaded was 1/1200 of the span. Deflections in the central panel were uniformly less than those in the outer panels. The maximum deflection found was at a bulkhead in an outer panel and amounted to 1/1000 of the span.

The stresses in the steel at the centre of the panel were found to be low, running from 2,000 to 4,000 pounds per square inch, and indicating a large amount of arch action reducing the computed stresses. The measurements indicated that the steel in the centre of the panel is most severely stressed for one panel only loaded. The diagonal and cross-band reinforcing were found to be taking practically the same stress, and this stress was approximately equally divided among the individual members of a band. In the steel over the columns the stress reached 16,000 pounds per square inch, so it is clear that this is the critical point in the design of such structures.

For the determination of the stresses in the concrete Young's Modulus was taken as 1,875,000 pounds per square inch. This gave compressive stresses at the edge of the capital of 650 to 675 pounds per square inch. While in this case these values are not excessive, it indicates that care must be taken to provide compressive reinforcement at this point if necessaryy. It is quite common practice to run the diagonal reinforcing straight through on the bottom, thus providing this compressive reinforcement and at the same time avoiding the need of placing four layers of steel in the upper part of the slab near the column which decreases to a considerable extent the effective depth of the slab.

The floor was carefully cleaned and closely examined for indications of cracks. With a load of 265 pounds per square foot faint cracks appeared at a bulkhead. Other such cracks appeared when the maximum load of 350 pounds per square foot was put on. One set ran along the centre of the cross-band, dying out at each end, thus indicating the tension in the upper part of the slab along the side of the panel previously mentioned. Another set appeared around the columns, and 2 inches to 3 inches outside the edge of the capital, furnishing another indication that the maximum moment occurs over the column, the critical section being at or near the edge of the capital.

With regard to the distribution of stress among the several bars of a band of reinforcing, some experiments made on broad, shallow beams by Prof. A. N. Talbot, of the University of Illinois, are of interest. The beams were 36 inches broad, 4 feet 10 inches long, and 3 inches deep, the ratio of depth to width being one-twelfth. They were loaded across their full width and freely supported at the ends for various proportions of their width. The beams were made and tested induplicate at an age of about sixty days.

The following table, from the National Association of Cement Users proceedings, 1911, shows a few of his results:

		Total load carried, in pounds.		
Beam No.	Supported.	Beam No. 1.	Beam No. 2.	Average.
711.1-2	Full width	15,550	15,800	15,675
713.1-2	Half width	15,000	17,000	16,000
715.1-2	Fifth width	14,900	12,250	13,500
717.1-2	Fifth width	14,550	16,000	15,300

All the beams had ten 3/8 inch round rods 3 inches from the face, and beams 717.1-2 had also 1/4 inch round rods on 4-inch centres crosswise of the beam.

From these and similar experiments he concludes that for a beam supported over one-half its width there is no appreciable falling off in the load carried. For a beam supported only one-fifth of the width the decrease in strength is slight. Other tests made by Prof. Talbot on footings, as well as Mr. Lord's extensometer tests, bear out this result.

Prof. Talbot states his conclusion thus: "The width of the resisting section, as governing the stress in the steel, is composed of the width of the pier, plus the depth to the steel on each side of this, plus one-half the remaining width of the footing." In ordinary flat slab designs this would include all the steel in both diagonal and cross-bands, and we may therefore conclude that it is all nearly equally stressed regardless of whether it passes directly over the column head or not. The above discussion refers, of course, to stresses produced by moments only, as the resisting section to shear stresses will obviously only be equal in width to the column.

Mr. C. A. P. Turner's method of design* is based on experimental data obtained from tests made on full-size single panels. Details of particular tests are not to hand, but the general method may be described. Tests were first made on the steel reinforcing and its yield point determined. The slab was then built, using this grade of steel, and after being allowed to season a reasonable time was loaded until the steel reached this yield point, which Mr. Turner claims to be able to recognize from the behavior of the slab. Then, by simple proportion, an exact working load for a given tension in the metal may be determined.

*"Concrete Steel Construction," by C. A. P. Turner, Chap. 3.

In this manner he obtained the formula $\frac{wl^2}{50}$ for bending moment in the mushroom system. His corresponding formula for deflection is $\frac{1}{7000} \cdot \frac{wl^4}{\Sigma Ad^2}$ where

A = the area of one reinforcing rod.
d = the depth of the slab to steel.
l = the span.
w = the total load per square foot of floor area.

This deflection formula is backed up by tests on panels in buildings in which the measured deflections closely approximated those computed from this formula.

Another interesting test was that made on four panels on the tenth floor of the A. J. Franks Building, Chicago, in a manner very similar to that used by Mr. Lord, and hence will only be briefly referred to. A full description of the test, together with tables of measured stresses, are given in the report of W. K. Hatt, consulting engineer, compiled for, and published by the Concrete Steel Products Company, of Chicago. The floor was of the well-known "Cantilever Flat Slab" type, which is the trade-name of this company, analogous to the term "mushroom" used by Mr. Turner.

Under the design load of 256 pounds per square foot the maximum stress in the steel was 4,575 pounds per square inch, occurring in the cross-band over the capital; and the maximum stress in the concrete was 677 pounds per square inch occurring in the drop of a central column. Under a load of 624 pounds per square foot the maximum stress in the steel was 10,095 pounds per square inch in the centre of the span of the cross-band, and the maximum compressive stress in the concrete was 1,685 pounds per square inch in the drop of the central column. The maximum tension in the longitudinal column reinforcing due to eccentric loading occurred at a corner column and amounted to 5,000 pounds per square inch under the design load, and 11,600 pounds per square inch under the maximum load.

The above figures bring out the fact that the design is overbalanced with an excess of steel, that is, the maximum permissible stresses in steel and concrete are not simultaneously realized. This condition probably exists in all present designs for flat slab floors.

BELGIAN COAL PRODUCTION.

The total production of coal in Belgium during 1912 amounted to 22,983,460 tons, against 23,125,140 tons in 1911 and 23,927,230 tons in 1910. This decrease was due to the strike in the Borinage district at the beginning of the year, and also to the limiting of the day's work to 9 hours. Although this fresh decline in production may appear discouraging, it is in reality not unsatisfactory, says the American Consul at Liege, for, in spite of the further reduction of the working day from 9½ hours in 1911 to 9 hours in 1912, there was a decrease of only 141,680 tons, while the production for 1911 was 800,000 tons less than that of 1910; if the strike in the Borinage, which lasted over a month, had not taken place, causing a reduction in the output of 500,000 tons, the total output for 1912 would have been considerably greater than in 1911. The conclusion to be drawn from this is that the limiting of the working day has not had the disastrous results anticipated. The coal mines proceeded to improve their machinery, tools, etc., and the results for 1912 go to show that the increased effective power of the engineers offsets the reduced work of the miners.

GAS AND OIL ENGINES FOR ELECTRIC SUPPLY STATIONS.

By A. N. Rye.

From time to time a number of articles have appeared in the technical press dealing with the generation of electricity by gas and oil engines. Certain of these articles have dealt with private supplies, and have been of considerable interest, but the conditions of public supply are so different from private supply that it is by no means certain that a type of machine which has been satisfactory in one case will be equally satisfactory in the other case; for instance, the question of reliability is of so much more importance to a public supply than to a private plant.

The articles dealing with gas and oil engines for public supplies have, in many cases, been of the nature of estimates, and many engineers are not satisfied that the figures put forward can be obtained in actual practice. Under these circumstances engineers may be interested in the results obtained in a central station depending almost entirely upon gas and Diesel engines, where both classes of engines are run in the same power house by the same staff and under the same conditions.

The public supply of electricity in the Island of Guernsey is undertaken by the Guernsey Electric Light and Power Company, Limited, and was recently described by A. N. Rye in the Electrical Review. The supply was started in 1900 from a small station at Les Amballes, equipped with the plant usually installed about that date, i.e., Belliss engines, Babcock boilers, surface condenser, economizer, battery, etc.

At a later date a demand for power developed in the granite quarries at a distance of about 2½ miles from the generating station; as this load increased it became impossible to deal with it from the Les Amballes station, and a new power station was built at St. Sampson's in the centre of this load, and the Les Amballes station was continued principally to supply the lighting demand in and around the town of St. Peter Port.

TABLE I.—Gas Engines, St. Sampson's, 1912.

Month.	Units generated.	Tons coal.	Lb. per unit gen.	Per ton.	Cost.	Per unit.
January...	51,720	75	3·2	17/10	£66 17 6	·31d.
February	50,628	68·5	3·0	,,	61 1 6	·29d.
March ...	41,024	60	3·2	,,	53 10 0	·31d.
April ...	47,185	46	2·14	,,	41 0 4	·21d.
May ...	67,231	58	1·93	,,	51 14 4	·18d.
June ...	54,845	52·5	2·14	18/6	48 11 3	·21d.
July ...	67,465	67·5	2·2	19/-	64 2 6	·22d.
August ...	72,172	75	2·33	18/-	67 10 0	·22d.
September	79,527	73	2·06	19/6	71 3 6	·21d.
October ...	101,126	90	2·0	,,	87 15 0	·21d.
November	118,739	100	1·9	,,	97 10 0	·20d.
December	93,214	84	2·0	,,	81 18 0	·21d.
Total ...	844,876	849·5	2·25		£792 13 11	·225d.

The first plant installed in 1904 at the new station at St. Sampson's consisted of two gas-driven sets nominally of 180 kw. each, together with pressure gas producers and a battery of 1,200 ampere-hours, 420 volts, capacity. Later in 1908 another set of 220 kw. was added. Early in 1911 a Diesel driven set of 165 kw. was installed, and in December, 1912, another similar set was put down. At the old station at Les Amballes, certain steam plant was dismantled in 1911 and two Diesel-driven sets, each of 135 kw., were installed.

Under normal conditions the whole of the load at both stations is carried by the gas and oil-driven plant, the steam plant being used only as a reserve during repairs to the more economical, but less reliable, internal combustion engines.

It will be seen that no engines were installed during 1912, except the last set at St. Sampson's, and this was not running until 1913; consequently in the following figures all the results are from engines which have run at least one year, and the majority for a longer period.

TABLE II.—OIL ENGINE, ST. SAMPSON'S, 1912.

Month.	Units generated.	Weight of oil, lb.	Lb. per unit gen.	Per ton.	Cost.	Per unit.
January...	46,154	34,957	·75	51/-	£39 15 3	·20d.
February	8,107	6,466	·8	56/6	8 1 8	·23d.
March ...	54,831	38,525	·70	,,	48 6 4	·21d.
April ...	46,966	32,281	·687	,,	40 9 8	·21d.
May ...	47,345	32,044	·677	,,	40 3 9	·21d.
June ...	43,976	29,689	·675	,,	37 4 8	·20d.
July ...	46,624	30,379	·651	,,	38 2 0	·20d.
August ...	46,053	31,400	·67	,,	39 7 7	·20d.
September	36,462	24,906	·684	,,	31 4 8	·20d.
October ...	30,259	21,228	·701	65/6	31 0 11	·25d.
November	4,999	3,503	·7	..	5 2 5	·25d.
December	35,909	26,515	·738	,,	38 15 6	·26d.
Total ...	447,685	311,893	·696		£397 14 5	·213d.

During 1912 the gas and oil engines generated 1,865,236 units, of which rather more than half was generated by the oil engines; consequently both classes of plant had to run for long hours.

Very careful monthly records were kept of the performance of each class of plant, and the accuracy of these figures is proved by the fact that the total of the invoices for coal and oil for the year exceeds the sum of the monthly figures by less than 2½ per cent., and this difference is probably due to small losses in storage, etc.

The figures in Tables I., II. and III., being abstracts from the monthly records, are worked out on the units generated, the units sold not being available each month.

In comparing the performances of the different types of engine, there are certain points to be taken into consideration.

TABLE III.—OIL ENGINES, LES AMBALLES, 1912.

Month.	Units generated.	Weight of oil, lb.	Lb. per unit gen.	Per ton.	Cost.	Per unit.
January...	59,459	40,045	·675	54/-	£48 4 5	·19d.
February...	73,010	47,234	·645	59/6	62 11 8	·20d.
March ...	54,381	36,813	·677	,,	48 15 6	·21d.
April ...	34,701	23,335	·672	,,	30 18 4	·21d.
May ...	39,028	26,247	·673	,,	34 15 6	·21d.
June ...	33,514	22,006	·657	,,	29 3 2	·21d.
July ...	34,698	21,827	·629	,,	28 18 5	·20d.
August ...	45,129	30,285	·67	,,	40 2 6	·21d.
September	26,857	17,750	·66	,,	23 10 4	·21d.
October ...	42,388	28,740	·678	68/6	43 18 8	·25d.
November	64,648	44,400	·688	,,	67 17 10	·25d.
December	64,862	44,760	·69	,,	68 8 11	·25d.
Total ...	572,675	383,444	·670		£527 5 3	·221d.

In the case of the gas engines, it must be remembered that two of these engines are more than eight years old; in 1911, they had got into a bad state of repair, with worn pistons, worn liners, etc., and it was decided to thoroughly overhaul all the gas engines and gas plant. This work was not completed until July, 1912, and the high fuel consumption of the first three months of 1912 is entirely due to the condition of the plant, and should be neglected when making comparisons. If, then, the months of April, May and June are compared, it will be seen that there was practically no difference in cost per unit for fuel between the gas and oil engines, but later in the year, although the cost of coal increased, the cost of oil increased in much greater ratio, and for the months of October, November and December the gas engines were very decidedly cheaper in fuel cost. This difference in cost is even more marked at the moment of writing, so much so that the Diesel engines are being run as little as possible, and the gas engines as much as possible. This preference for the gas plant is entirely due to the enormous increase in the cost of fuel oil, which has gone up 75 per cent. in price in less than two years.

In Tables II. and III., if the "lb. of oil per unit" column is examined, the wonderfully even running of the Diesel engines will be noticed.

Table III. shows this to most advantage, because the load factor of these engines is more nearly constant from day to day, and also because the engine in Table II. has developed more defects than the engines in Table III., which have run practically without trouble for the whole of the year.

The running of these Diesel engines shows very clearly one remarkable fact—the full load guarantee being .67 lb. of oil per unit, the actual consumption for the year exceeds the guarantee figures by less than 5 per cent.

Everyone who has had to run steam plant under similar conditions knows that the test results will be exceeded by at least 50 per cent., and even with gas plant it is difficult to keep within 20 per cent. of test figures.

It is quite possible to take one or two individual figures in these tables and query their accuracy. For instance, in Table III. the month of July shows an impossibly good figure under "lb. per unit." There are reasons for this, and other small errors, which it would be tedious to explain, and it was thought advisable to give the figures exactly as recorded without any alterations; that any small error in one month corrects itself later is proved by the close agreement with the figures for the complete year.

Table IV. shows the costs per unit sold for 1912 abstracted from the balance-sheet and given in detail, so that the station costs can be seen separated from the distribution costs. It should be mentioned that no part of the cost of the special overhaul to the gas plant is included in these figures.

TABLE IV.—Costs Per Unit Sold for 1912.

Generation—	
Fuel	.33d.
Oil, waste, water, etc.	.08d.
Wages and salaries	.16d.
Repairs—Buildings, plant, tools	.16d.
Accumulators	.05d.
	.78d.
Distribution—	
Wages and salaries, repairs mains, repairs meters, etc.	.08d.
Rent, rates, taxes and insurance	.07d.
Management	.18d.
Total running costs	1.01d.

The above cost is without any interest charges, etc.

$$\text{Efficiency} = \frac{\text{Units sold} \times 100}{\text{Units generated}} = 78 \text{ per cent.}$$

The efficiency figure is given so that direct comparison may be made with the monthly figures which are worked out on units generated; reducing the year's fuel cost to this basis, the result is .257d. per unit generated, the excess over the monthly figures being due to the running of the steam plant under very uneconomical conditions.

The above figures give the facts of the case, but would not be complete without some account of the running of the plant and the opinions formed by the engineers in charge of it.

So far as fuel costs are concerned, there is no doubt that in the special circumstances in Guernsey both gas and Diesel engines are very economical; anthracite peas for gas making can be bought at about the same price as small steam coal, and, in practice, this means that the fuel bill for steam working would be nearly double the cost for generation by gas. The fuel costs of the Diesel engines before the recent heavy rise in the price in oil were practically the same as for gas, but, at present prices, the cost of running the Diesel engines is so heavy, that it is fairly certain that no more engines of this type will be installed until oil prices fall.

Although the internal combustion engines have proved economical in fuel cost, it is certain that part, at least, of this saving must be set aside to pay for the heavier running costs in other directions; for instance, the lubricating oil bill amounts to over 10 per cent. of the fuel bill, and costs probably three times as much as the oil for a steam-driven station using reciprocating engines; while, if turbines are used, this item of expenditure becomes very small. The labor costs are highest for gas engines and lowest for Diesel engines, steam plant taking a position about midway between the two.

As compared with steam, the supervision charges are higher for both gas and oil engines. With internal combustion engines, the repair costs are one of the most serious items, and, in spite of all statements to the contrary, there is no doubt that quite a large amount of the saving in fuel must be spent on repairs.

After two of the gas engines had run for seven years and the third for three years, they had reached such a condition that repairs costing well over £2,000 were necessary to put them in good order, although large sums had been spent on repairs each year. This statement must, however, be qualified by explaining that these particular engines were of an early type, and there is no doubt that more modern engines could be maintained at a lower cost.

The Diesel engines have not been running sufficiently long to require much in the way of ordinary repairs, and for the greater part of the time all breakages have been covered by the makers' guarantees, but from the experience up to date it seems reasonably certain to expect that the repairs will be more costly than for steam plant, though it is hoped that the cost will not be so heavy as for the gas plant.

Reliability is a point of supreme importance for a public supply. Experience with the gas engines showed that internal combustion engines were not suitable for a public supply without the assistance of a large battery, and it is no exaggeration to say that without the battery it would have been quite impossible to maintain the supply with reasonable economy; there are so many things which may suddenly cause a gas engine to give up working, and it is impossible to guard against them. Therefore, either an extra set must always be running in parallel, thus increasing the fuel, oil and attendance charges, or a battery must be installed.

With this experience as a guide, it was decided that when Diesel engines were installed at Les Amballes station, it would be advisable to alter the battery arrangements, so that an output equivalent to the full load of one Diesel set could be available instantly if one of the running sets failed; this precaution has proved most useful; it allows the engines to be run at practically full load with safety, and it has saved a number of failures of supply that otherwise would have taken place.

It must not be assumed from the above remarks that the failures of gas or Diesel engines are always of a serious nature; the great majority of accidents that might cause an interruption to supply are quite trivial, and can be rectified in a few minutes, but they happen so suddenly that there is no time to run up a spare set. With the gas engines it may be a trifling defect in the ignition gear, or something causing pre-ignition or back firing. With the Diesel engine it may be a needle valve stuck open, or a compressor valve hung up; all of these defects may be of no importance, and the engine may be on load again in a few minutes, but unless a spare set is running, or there is a battery, they may cause an interruption to the supply.

Experience has shown that the gas engines are more subject to these little troubles than the Diesel engines, in fact, the Diesel engines have frequently run for several months without an involuntary stop, whereas the same cannot be said of the gas engines. On the other hand, the Diesel engine failures give less warning, and usually take longer to put right.

There is no doubt that, if a supply depends entirely on internal-combustion engines, more spare plant must be installed than in a steam-driven station. In the first place, internal combustion engines cannot be overlooked for emergency purposes, and of even more importance is the fact that a defective steam plant can often be run until the load falls at night, whereas a defect in an internal combustion engine must receive attention without delay. For instance, a leaky valve or a blowing joint on a steam engine can usually wait for attention, but on a gas engine, and more particularly on a Diesel engine, these defects may stop the set at once, and even if they do not do so it is generally advisable to shut down the set without delay to avoid the risk of serious damage, as the high temperature and high pressure of the gases cut the metal surfaces with surprising rapidity and may do much damage in a short time.

Another reason for having plenty of spare plant, particularly with Diesel engines, is the considerable degree of accuracy essential when making adjustments and repairs; this accuracy cannot be obtained on work carried out at night by a tired staff of men racing against time to get the plant on load again.

To sum up briefly, internal combustion engines can give a perfectly satisfactory supply, particularly if batteries are installed; but they are essentially different from steam plant, and must be installed and run with due regard to this fact.

Under favorable circumstances, these machines are economical, but it must not be forgotten that there are other expenses besides the fuel bill, and the fuel bill of the internal-combustion engine must show a handsome saving to justify the use of this class of plant.

Of the two, the Diesel engine appears to have certain advantages for central-station work, but, as long as the market for oil is subject to such severe fluctuations, the use of this engine is likely to be restricted to special cases.

The most useful field for the internal-combustion engine appears to be in small central stations; as the size of the station increases, the advantages of this type of plant decrease, until a point is reached where internal-combustion engines can only pay in exceptional circumstances, and at the present date this point appears to be reached when a

station under average English conditions is of sufficient size to use steam turbines of 1,000 kw. or larger.

The results in Guernsey have fully justified the installation both of gas and Diesel engines, the great saving in the fuel bill being more than sufficient to balance the increased costs in other directions.

BLAST-FURNACE SLAG FOR BRICKS.

Slag bricks are now made by several standard methods, most of them involving hardening either in a steam chamber or an atmosphere of carbon dioxide. During the last few years experiments have been carried out in Germany on the use of slag bricks for engine foundations. The mortar used in these experiments consisted of one part burnt lime and ten parts granulated foundry-iron blast-furnace slag. These materials were thoroughly ground together in a mill, and the brickwork kept carefully moist during building and after being finished. In April, 1912, large cubes were taken from the various foundations and tested under compression. The results varied from 1,166 pounds to 2,688 pounds per square inch, comparing very favorably with best Portland cement concrete. The cost per cubic meter of brick work built of slag bricks with bricks at 17s. per 1,000 was shown to be about 11s 3d. The corresponding cost of concrete foundations varied from about 10s. 6d. per cubic metre for a 1 to 5 mixture to 12s. 1d. for a 1 to 12 mixture. Finally, tests were made on cubes built up of slag bricks hardened by means of carbon dioxide They were built on April 3rd, 1912, using mortar made as before, and were surrounded with moist sand, which was moistened afresh each day for eight days. The results in pounds per square inch were:—

	Test No. 1.	Test No. 2.	Test No. 3.
May 3rd, 1912	2,133	1,835	1,707
June 2nd, 1912	2,290	2,133	1,920

The ratio of lime to granulated slag was 1 to 8 in test No. 1, 1 to 10 in test No. 2, and 1 to 15 in test No. 3.

A GIGANTIC DREDGING CONTRACT.

The contract recently awarded to a Canadian firm for the dredging in connection with the water front development of the city of Toronto under the direction of its Board of Harbor Commissioners is one of the largest ever undertaken in Canada. Some 31,000,000 cubic yards will be removed from the harbor at an estimated expenditure of nearly $6,500,000. Dredging operations will be carried on over the entire water front as far west as the Humber River, and the successful tenderer is getting plant in readiness to undertake the deepening of the harbor immediately. The work of filling the industrial area formerly known as Ashbridge's Bay will be carried on simultaneously. E. L. Cousins, B.A.Sc., is harbor engineer to the Commisssion.

VANCOUVER BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS

The accompanying photograph of the Vancouver Branch was taken on the occasion of a visit on May 10th to the Coquitlam Dam which is being constructed by the Vancouver Power Co., Limited. We are indebted to the resident inspecting engineer for taking the photograph, and to Mr. Challies, superintendent, Water Power Branch, Department of the Interior, for copy of it.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance

Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.

ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.

H. IRWIN, B.A.Sc., EDITOR. A. E. JENNINGS, ADVERTISING MANAGER.

HEAD OFFICE: 52 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JUNE 12, 1913. No. 24

CONTENTS OF THIS ISSUE.

REPORT ON INDUSTRIAL EDUCATION.

The report of the Royal Commission on Industrial Training and Technical Education ranks among the most important ever submitted to a Canadian Parliament. If its recommendations are acted upon and properly carried out, Canada's handicap due to lack of technical instruction will in due course assume lesser dimensions. The burden has been long standing. For half a century has been felt the need of a kind of education more closely allied to industry in its many branches. The appointment of the Commission in 1910 was a masterful stroke towards alleviating a growing responsibility.

A section of the report was submitted to the House of Commons last week, and other sections are to follow in the course of a few months. Sufficient has been presented to show that the Commission is of firm conviction in the matter of industrial training. It recommends a number of things, among which is a Federal grant of three millions yearly for the next ten years for foundation purposes, to be apportioned among the provinces on a per capita basis.

Of particular interest to engineers and manufacturers is the recognized need of courses of technical instructions for workmen, foremen, and managers, varying in degree from the general instruction for the increase of skill and ability among laborers, to the improvement of established courses in the existing institutions of highest rank. The decided stand taken on the question of technical schools co-ordinated with the industries, rather than purely trade schools, voices the opinion that practical workshop experience is the better training for thoroughness, speed, discipline and general industrial efficiency among men.

Important among its recommendations is that pertaining to instruction by correspondence from Provincial or inter-Provincial institutions. Canada is woefully behind in this form of dissemination of knowledge. Under the Commission's recommendation a few unfavorable aspects associated with instruction by correspondence would invariably disappear. The frequent visits of qualified travelling instructors to places too small to maintain the services of a permanent supervisor, will likewise tend to remove many of the difficulties and obstacles which arise and for a time hold instruction at a standstill, not infrequently causing a complete cessation of effort.

It is to be hoped that the Dominion Parliament will go a long way towards fulfilling the Commission's recommendations, now that the necessary information is before it. Canada has never had such an exhaustive knowledge of her own peculiar situation in matters pertaining to her capabilities and limitations in industrial training as she now possesses.

THE NEEDS OF THE HIGHER INSTITUTIONS.

The recommendation of the Commission on Industrial Training, which reads: "That existing institutions of college rank should receive whatever additional financial support may be necessary to enable them to adequately fill their place in a national system of industrial training and technical education," will be deeply probed, it is to be hoped. Canadian universities are well known to be struggling through a period of financial embarrassment sufficient to prohibit any development whatsoever towards the increasing demands upon them, and grave fears are expressed here and there of the necessity of an

abridgment in departments already established. If industrial development is the question of the hour, it should be recognized in institutions now sufficiently equipped with qualified instructors and apparatus for the many phases of industrial training harbored within.

The universities and colleges have been making severe raids upon their money-bags to provide technical courses to meet the demands from an increasing number of students and the spread of industry over the Dominion. While these quantities increased, the former became lighter, and the growing inequality has not been adequately recognized by the Government. For instance, the University of Toronto authorities are fully aware of the crying need of a course in Ceramics. Emphasis from the Canadian Clay Products Manufacturers' Association at the time of their recent convention was unnecessary from the viewpoint of apprising the University of conditions in the clay-working industry. Their urgent demands, however, together with others, disclosed the fact that the great institution of learning of the Province of Ontario lacked funds to establish, even on a small scale, a course of instruction to serve their needs, although there was sufficient space available in its laboratories to house such a department.

The rapid growth and development of the country and the further application of science and scientific methods to all forms of production, construction, conservation, and administration, will continue to call for still larger number of graduates. In consequence the universities and colleges are sure to experience further necessity of increased financial support. It is gratifying that the Commission is of the opinion that this should be provided from a source that will not necessitate the fees required from students to be so high as to exclude suitable young persons who may seek the highest grade of technical instruction.

MONTREAL'S TUNNEL PROPOSAL.

A gross revenue of $3,000,000 and a net revenue of $1,500,000 for the first year, with the promise of 12 per cent. profit at the expiration of ten years, all derived from an initial outlay of twenty millions, is the subject of a report received by the Montreal Board of Control from Mr. F. S. Williamson, consulting engineer. The expenditure would provide for an underground tram service, with twelve and one-half miles of two-track lines. He estimates a four-line tube to cost $30,000,000, or $530 a foot, to which must be added the cost of stations.

Mr. Williamson is of the opinion that the trolley car in Montreal is doomed to disappear, and that before many years surface car traffic on business streets will be subjected to prohibitive measures, giving place to motor 'buses and tunnel systems.

The report is interesting in that the congestion of traffic on the central thoroughfares of both Toronto and Montreal are demanding material relief of some kind. The problem of surface transportation is certainly not new in either city, and, although the optimism of Mr. Williamson is to a degree corroborated by the adoption of motor 'buses and tubes in many cities in Europe and the United States, still we are rather inclined to believe that the disappearance from our busy streets of surface cars, with their motive power necessities, is not an affair of the next few decades.

It is stated that the chief engineer has been asked to report to the Montreal controllers on the report.

EDITORIAL COMMENT.

What is claimed to be a record in ground tunnelling is reported in connection with the Canadian Northern Montreal Tunnel and Terminal Company's work in that city. In thirty-one days 810 feet have been completed, the daily progress averaging from 22 to 28 feet per day for the latter part of this period. It will be remembered that the tunnel when finished will exceed three miles in length. Mr. S. P. Brown, managing engineer for Mackenzie, Mann & Co., is chief engineer of the work.

* * * *

The Canadian Northern Railway has been successful in its application to the House of Commons for a further subsidy to aid in the completion of its Transcontinental line. The House recently voted aid to the extent of $15,600,000, all of which, with the exception of $1,000,000, will be devoted to construction work on the line between Edmonton and Yellowhead Pass, B.C. The balance is for the Toronto to Ottawa line. The Temiskaming and Northern Ontario Railway was also subsidized to the extent of $2,000,000, and a bill authorizing the loan of $15,000,000 to the Grand Trunk Pacific Railway was passed.

* * * *

In a recent trade and commerce report the Canadian varieties of graphite were claimed to excel the Ceylon product for a few speciai purposes, and was suitable for many more, providing proper methods were adopted in grading the product. Although no regular trade has been established with the United Kingdom, the statement is encouraging, and if veins of uniform composition can be suitably worked and careful means employed to properly grade the graphite according to quality, Canadian producers will be able to establish a considerable business and satisfactorily compete with the plumbago industry of Ceylon for many purposes. The use of graphite seems to be constantly on the increase, and when the Canadian industry has completely emerged from the many preliminary obstacles which, up to the present, have been a most serious handicap, it is to be anticipated that more definite and systematic efforts will be successful in securing a share of the business open in Great Britain.

* * * *

At the annual Convocation of the University of Toronto on June 6th the honorary degree of Doctor of Science (D.Sc.) was conferred upon Mr. T. Kennard Thomson, who is a graduate of the School of Practical Science, '86, and whose prominence as a consulting engineer is widely known, especially in connection with caisson foundation practice and skeleton steel and reinforced concrete construction in New York City. The honorary degree is a new one in the University of Toronto, and the event is of further interest as it marks the first conference of an honorary degree by this University upon one of its graduates from the Faculty of Applied Science and Engineering or from the old School of Practical Science, and, in fact, upon any follower of the profession of engineering. It will be remembered that the University of Toronto has this year instituted an additional academic degree of Master of Applied Science (M.A.Sc.), open to the holder of the degree of B.A.Sc. who spends an additional year in attendance on a special course of study, upon which work he also compiles a thesis before presenting himself for the examination leading to the degree.

MODERN PIER CONSTRUCTION IN NEW YORK HARBOR

DISPLACEMENT OF WOODEN DECKS OWING TO EXPENSE OF MAINTENANCE — REINFORCED CONCRETE DECK SLABS ON WOODEN SUPERSTRUCTURE—MOISTUREPROOF AND PERMANENT

By CHARLES W. STANIFORD, M. Am. Soc. C.E.

THE present general port activity and agitation for a modernization and expansion of the dock and wharfage system in New York City indicate that at least the community at large seems the realize the necessity of keeping its producing plant, the harbor, up to date and at the top notch of efficiency. There can be no question that New York City's supremacy as a manufacturing and distributing centre is due to wise adaptation of its magnificent harbor. The phenomenal increase in the size of vessels, necessitating longer docks, and the great and constant increase in tonnage entering the harbor, both demand determined action in port development.

New York is approximately equidistant from the ports of Northern Europe and South America. Therefore, it will undoubtedly receive additional impetus in its commerce and shipping on the completion of the Panama Canal. Further, on the completion of the New York State Barge Canal, it will have a direct all-water route to the Great Lakes and the North Middle States and Canada, and the Cape Cod Canal will tap New England commerce.

Harbor Development.—In this period of harbor activity, it will be of interest to both the public and the engineer to describe the gradual development of the harbor, as such development was first systematically undertaken by the city, when, in 1870, the Department of Docks was organized for this purpose, and to show the types of pier construction evolved.

In considering the history of dock development in the city of New York, through the instrumentality of the Department of Docks, it must be borne in mind that, in its early days, the department was greatly handicapped in its progress by the fact that the city actually owned only a very small portion of its great water-front, most of it having passed, by successive water grants, into the control of private interests.

It had been the policy of the New York State Government, prior to the organization of the Department of Docks, to give to corporate interests or private persons grants of land under water in that portion of the present city outside of Manhattan, the object and hope in making such grants being that such cession of land under water would be a sufficient incentive for the investment of private capital in the development of the port.

The hopes of the state and city were fully realized; in fact, they were so generally fulfilled that when the port authority, created by the legislature in establishing the Department of Docks for the purpose of intelligent development under municipal control, began to consider the expansion of wharfage facilities to meet the demands of the growing commerce, it found but little actual water-front in possession or under control of the city.

That the early city authorities used wisdom and foresight in their work of providing for proper expansion of the harbor, is shown by the fact that, through their sagacity and good judgment, the number of piers in the harbor, owned by the municipality of New York, grew from 107 in 1868, valued at $20,000,000, to 232 in 1913, valued at $100,000,000 or more.

There has accrued, therefore, to the city, a return on its investment in this development of the dock system, a large sum of money in increased valuation and annual rent receipts, the latter aggregating in round figures about $4,000,000 per annum, the interest at 4% on a capital of $100,000,000.

It will be seen that, at the outset, the Department of Docks concluded that proper growth and expansion of the harbor under municipal control depended on the acquisition and control of water-front property; and since the organization of the Department of Docks, this has been the policy followed by the city.

When, in 1870, the municipal authorities undertook the burden of increasing the wharfage facilities of the harbor, and of procuring funds for this purpose, it became necessary, as a basis for their work, to determine on some economic form or type of construction, both in regard to the pier structure proper and also the general location with respect to the available shore front, whereby the maximum wharfage accommodation could be developed without excessive or prohibitory cost.

The limited funds available and the small extent of water-front lands under the actual control of the city called for the greatest economy in space, the land requiring intense development in order to obtain the greatest possible extent of wharfage.

Bond issues to be applied to the development of wharfage had to show the same return on the investment, when executed by the city authorities, as if these finances were handled by private parties or corporate interests. Therefore, what might be termed the "principle of economy in expenditure of land and funds" was, of necessity, followed, and this principal was generally adopted by private interests as well, the consequent intensive use of the water front resulting in the adoption of a uniform method of development by a definite system, namely, parallel piers generally at right angles to the general direction of the water-front, with intervening slips wide enough to accommodate vessels of the type intended to berth at the piers.

This parallel system of economically constructed piers, with its resulting economy in space occupied and capital expended, was undoubtedly one of the greatest factors in stimulating the development and expansion of the wharfage facilities in the harbor, and in keeping them abreast of the constant increase in shipping and commerce. It has also created by far the greatest wharfage space of any harbor in the world.

The wooden pier, consisting of a timber deck and floor system supported by timber piles, became the adopted type. It was cheap, durable, and readily adaptable to all classes of shipping. One of the most important characteristics of piers of this type is the ease and economy with which it may be removed entirely, reconstructed wholly or in part, or expand-

* Extracted from Proceedings Am. Soc. C.E., May, 1913; aper to be presented to the society September 3rd.

ed at a low cost, to meet the increasing needs of commerce and shipping. A dock or system of docks sufficient to accommodate the shipping at the time it was built, might be found to be inadequate and obsolete within a comparatively short term of years, a complete re-arrangement being then necessary.

With timber structures, this transformation or reconstruction is a simple, rapid, and economical undertaking; it is difficult and costly with structures of stone, concrete, steel, etc. The use of concrete piles, reinforced concrete substructures or similar forms of construction, therefore, would not only have resulted in high first cost of construction, but the difficulty and expense incidental to the periodical removal, reconstruction, or expansion of dock structures of this type, as necessitated from time to time by the growth of shipping, would have rendered harbor construction work, as a revenue-producing municipal investment, practically impossible, and, consequently, would have greatly retarded the development of the harbor.

Types of Pier Construction.—The United States Government, by virtue of its power to control all navigable waterways in the country, established along the entire water-front or shore line of New York Harbor two lines: one the bulkhead line, which limits the extent outshore of the solid filling or reclaimed land under water; the other, the pierhead line, which determines the limit to which piers may extend beyond the bulkhead line. These piers must be of such construction that the free flow of the tidal water shall remain uninterrupted by the supporting columns. This construction, being a condition wisely insisted on by the Government to preserve tidal conditions and currents, governs, to a great extent, the handling of vessels, particularly of large ones, and affects the sanitation of the city, in that it prevents the accumulation of sewage and refuse which would occur in closed slips. With open slips, such matter is carried away by, and disseminated in, the tidal flow. All pier construction is limited to the area included between the bulkhead and pierhead lines.

The pier which meets these requirements, and was adopted by the city in its early history as the type of structure for berthing vessels (and also adopted by all private and corporate interests), is a wooden structure throughout, consisting of a deck resting on piles driven into the mud or hard bottom. The physical features of the harbor, the geological formation of the bottom, and the condition of the water, fortunately permit the adoption of this type of construction, which, in many other parts of the world, is not adaptable because the life of the timber itself in the water would not be permanent or fairly long-lived. Wood-boring animals, the teredo, limnoria, etc., are very little in evidence, and, therefore, wooden piles are practically permanent below the water-line in almost all parts of New York Harbor.

The prominent objectionable feature to wooden pier construction is the expense necessitated by the constant repairs of the deck sheathing and the continuous wear and tear of the fender system extending along the sides and outer ends of the piers. As to the remainder of the structure, piles, floor system, etc., its maintenance and repair is very economical and consists generally in the replacement, from time to time, here and there, of decayed portions of the timber above mean low water only, at inconsiderable expense.

Until seven or eight years ago, the piers were generally built with decks of yellow pine, 4 in. thick, laid on a system of yellow pine floor structure of ranges and stringers. This deck plank in turn was covered with a second layer of either 3- or 4-in. plank sheathing, laid diagonally or at right angles to the deck proper, to form a wearing surface for the traffic.

Constant repairs and renewal of this deck sheathing, caused by the wear and tear of team traffic, is augmented in great measure by the moisture, horse urine, etc., which saturates the wood and eventually finds its way to the underlying deck and rangers. This forms the greatest item incident to the expense of pier maintenance, the average life of the sheathing for most busy piers being about 6 years, or requiring a 17% renewal annually. As the cost of the deck sheathing is generally about 12% of the total cost of a pier, it will be seen that these sheathing repairs would aggregate 2% per annum of the cost of the entire structure.

New Pier Construction Practice.—Notwithstanding the necessity for constant repairs to the deck sheathing of the wooden pier, the parts of the remainder of the structure—rangers, caps, stringers, piles, and bracing—give excellent service. Maintenance is economical, the average life of the structure above mean low water line being from 20 to 25 years, the repairs aggregating an entire renewal above low water in that period of time. As the life of the piles supporting the structure is practically permanent when submerged below the water, the entire structure can be rebuilt after this period and made practically new by "bench capping" such piles as may be decayed above the water line and renewing the stringers, caps, deck, and sheathing; in other words, the pier structure proper, after a life of 25 years, is readily susceptible of renewal above the water line, the supporting piles below that line being to all intents and purposes permanent.

It will be readily seen that the life of the wooden pier structure would be prolonged still further, and the cost of maintenance and repairs reduced, by the elimination of the objectionable wooden deck sheathing and its replacement by some form of deck impervious to moisture and resisting the wear and tear of traffic.

It was with the object of eliminating this large repair expense incidental to the maintenance of the sheathing, and

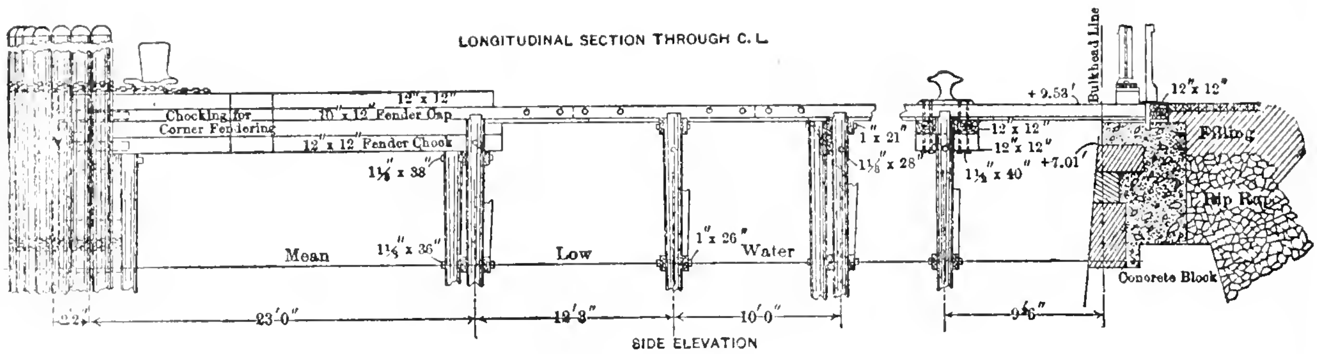


Fig. 1.—Detail of Single Story Reinforced Concrete Deck.

reducing maintenance cost generally, that a serious investigation and study was undertaken of the problem of producing a permanent deck surface supported by timber piles, assumed as permanent below the water line.

This study has resulted in the entire elimination of the old style of wooden deck in new structures, and the production of a new type consisting of reinforced concrete laid directly on the transverse cap system of the wooden pier substructure. This concrete is laid in slabs, spanning the pile bents practically as simple beams.

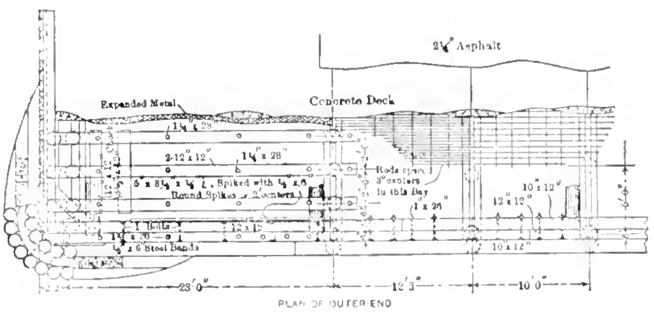


Fig. 2.—Corner Construction Reinforced Concrete Deck.

This new type of deck eliminates not only the 4-in. deck sheathing, but also the 4-in. deck proper and the underlying 12 by 12-in. yellow pine ranger system longitudinally of the pier on top of the transverse cap system, further increasing the life of the substructure.

A structure was thus evolved which had a permanent deck practically impervious to the penetration of moisture to the substructure, readily renewable from low water to the under side of the concrete deck, and permanent below the water line, with a first cost about equal to that of the old wooden deck pier.

The first step in the elimination of the great cost factor, the renewal of the deck sheathing, was the replacing of this sheathing by a concrete wearing surface, from 4 to 6 in. thick, laid directly on the old type of timber decking. This type forms a deck surface which is impervious to moisture, and is, therefore, a protection to the substructure, as well as a saving in maintenance.

The unit of cost of construction of a pier depends in a large measure on the size of the pier. As the outer portions, the sides, and outer end of a large pier are more rigid and heavier than those of a smaller pier, and, therefore, cost more in both labor and material, the relative cost per square foot of a short pier is considerably larger than that of a long one. The average cost of the old wooden deck pier of large dimensions is from $1.00 to $1.15 per sq. ft.

Further investigation and study resulted in the entire elimination of the wooden deck plank, deck sheathing, wooden floor rangers, etc., and the adoption of the present type of pier deck, as before mentioned, consisting of a reinforced concrete slab, 10½ in. thick, extending from centre to centre of the transverse pile rows placed generally 10 ft. apart. This slab is designed to carry a live load of 500 lb. per sq. ft. for the 10-ft. span between pile rows, and is reinforced with ⅝-in. square steel rods. The latter run longitudinally of the pier, are 6 in. apart, and are staggered so that only alternate rods terminate on the same pile row, with ⅜ by ⅜-in. separating rods. The slab is of 1:2:4 Portland cement concrete, with ¾-in. broken stone, the upper ½ in. of the slab being of Portland cement mortar finished smooth. This rod reinforcement is intended to be standard, but the substitution of trade sizes of equal strength and efficiency is permitted, subject to approval.

Definite illustrations of this type of pier construction are found in the two new piers recently completed by the Department of Docks and Ferries at the Gowanus Section, South Brooklyn, one at the foot of 31st Street, 1,475 ft. long, and the second at the foot of 33rd Street, 1,616 ft. long, each pier being 150 ft. wide. These piers are among the finest in the harbor, and are probably the largest of their type in the world. The unit cost is practically the same as that of the old wooden deck type. The decks have a crown of about 8 in., in order to shed the water. The in-shore end of the concrete deck rests on the bulkhead wall, but is not attached thereto, a horizontal plane joint allowing the deck to slide on the wall as it expands or contracts on account of changes of temperature.

Twenty-six piers with concrete decks have been built by the department during the past seven years. The earlier type, as exemplified by the Chelsea Section piers, consists of a 6-in. concrete deck surface reinforced with expanded metal and laid directly on the deck planking. The next type produced omitted the deck plank, and is represented by eight piers with decks consisting of a concrete slab, 6½ in. thick, reinforced with expanded metal, the slab spanning yellow pine rangers running longitudinally of the piers and generally about 6 ft. apart.

The final type evolved, omitting the timber floor system entirely, and placing a concrete slab reinforced with longitudinal steel rods directly on the timber-capped transverse pile rows, is represented by eight piers, the most important examples being those at the foot of 31st and 33rd Streets, South Brooklyn, and the Municipal Pier at Stapleton, Staten Island.

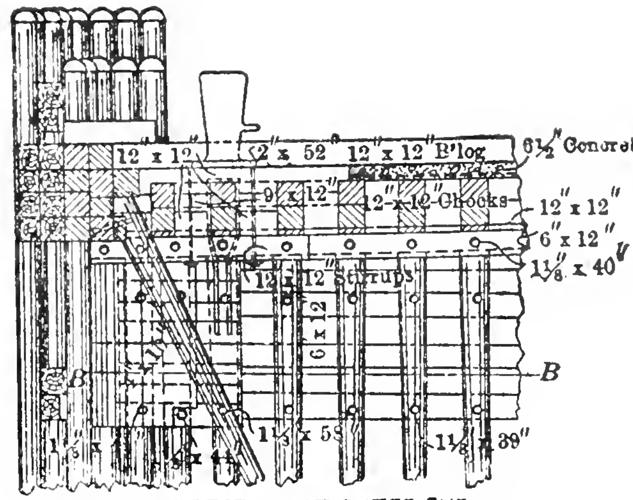


Fig. 3.—Pier Construction With Reinforced Concrete Deck.

All these piers have been built where the condition of the river bottom underlying them was such that no settlement could occur, and they have behaved admirably. No repairs have been necessary, except to the fender system, and none are anticipated for many years to come, excepting the renewal here and there of an imperfect pile, where rot may appear above the water line. Such renewals can be made at a minimum of cost—a few dollars per pile—by bench-capping, without any interference whatever with the integrity of the reinforced deck itself.

Column Foundations.—For single-story sheds, where additional bearing strength is required in the new concrete deck pier for shed column or superstructure support, the question

has been treated in general in the same manner as in the other parts of the structure, that is, by adding the necessary number of piles to carry the load concentrations, assuming the piles to be permanent below low water and easily renewable above that plane.

Concrete Deck Pier.

Cost of construction, 31st Street Pier, South Brooklyn, no asphalt surface	$0.87 per sq. ft.
Cost of construction, 33rd Street Pier, South Brooklyn, with asphalt surface	0.97 per sq. ft.

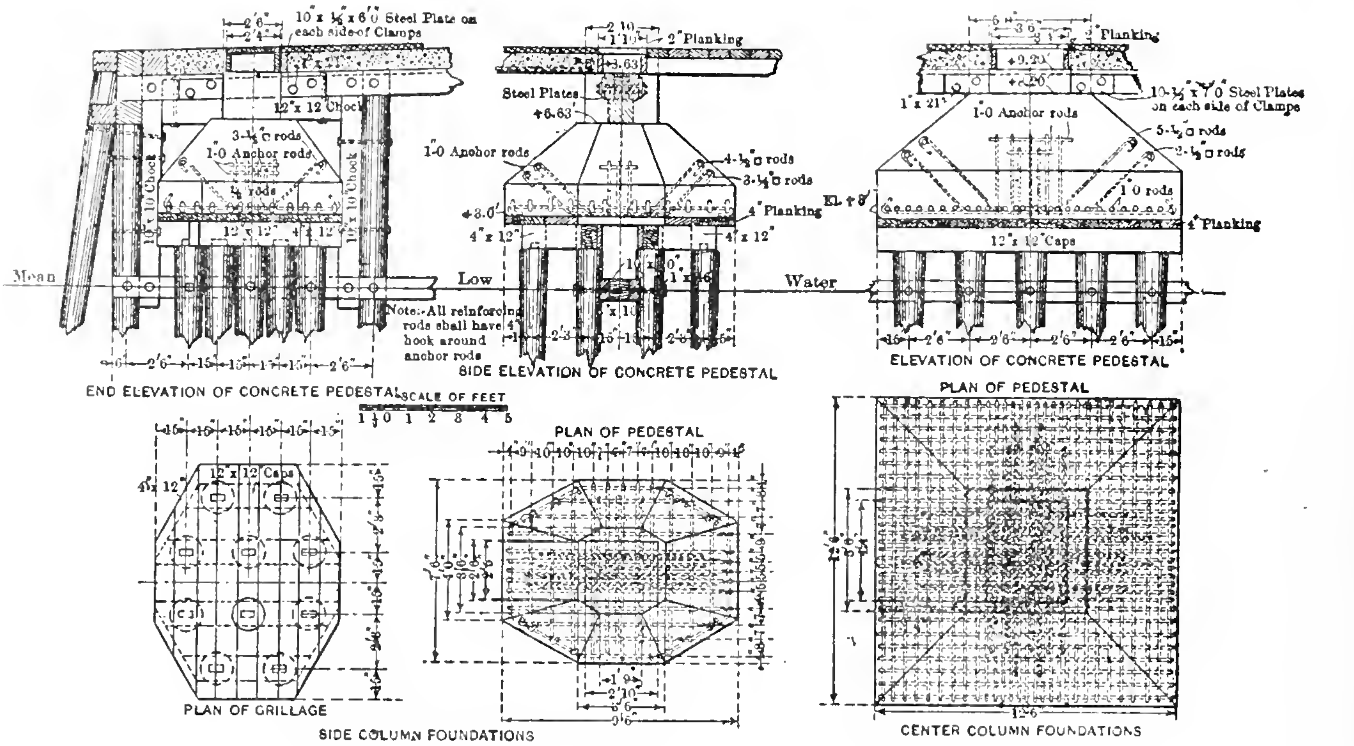


Fig. 4.—Details of Reinforced Concrete Deck and Column Pedestals, Two-Story Shed.

Where heavier concentrations occur, as, for example, in double-deck or two-story sheds, the piles are cut off at or near low water and covered with a timber grillage; built on this grillage are reinforced concrete pedestals, extending to the deck level, to carry the shed columns.

Railroad tracks, being a requirement on the South Brooklyn piers previously described, are carried on four lines of 15-in. steel I-beams, placed on the transverse clamp system of the pile rows and extending from the in-shore end of the pier sheds to within 60 ft. of the out-shore shed wall. The beams rest on steel saddles placed on the clamps, and are entirely encased in concrete.

Cost of Construction, Maintenance and Repairs.

Average Cost of Construction of Wooden Deck Piers, $1.00 to $1.15 per Square Foot.

Repair Costs of Wooden Deck Pier.

Description.	Percentage of total original cost.	Renewal required.
Sheathing	12	Every 6 years.
Backing log	1.8	Every 8 years
Fender chocks, including vertical sheathing	4	Every 10 years.
Fender piles	4.7	Every 12 years.
Decking	11.3	Every 15 years.
Bracing	7.1	50% in every 20 years.
Rangers and caps	24.4	50% in every 20 years.
Piles*	34.7	33⅓% every 20 years.

*Above M.L.W. only.

Economy being a prime factor in its construction, it was decided to try out the concrete deck surface for wear and tear of heavy team traffic, and the earlier decks, therefore, were finished with a smooth mortar surface to receive this traffic. Two years of experimenting on these lines, determined the fact that though the concrete surface was admirably adapted to light traffic, cargo handling by hand or

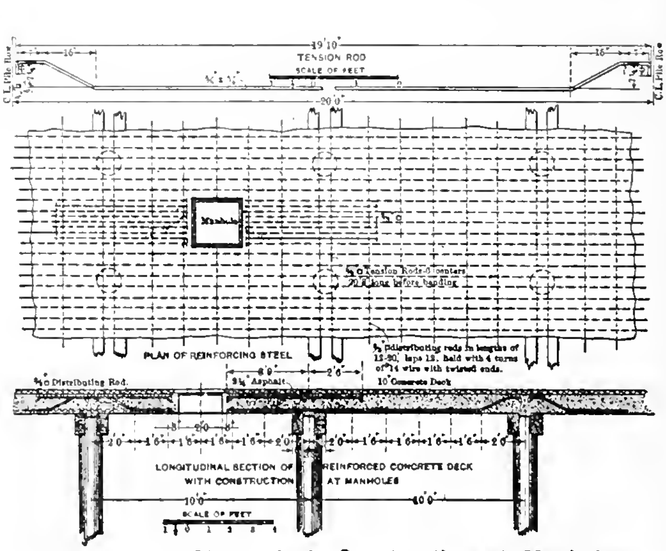


Fig. 5.—Two-Story Shed—Construction at Manholes.

motor trucks, etc., it could not stand the concentration of heavy team traffic confined within narrow lanes located generally in the centre of the pier. The grinding and turning of heavily laden trucks inside these narrow lanes or zones gradually caused surface rupture of the top coat of mortar.

It was decided, therefore, to place an asphalt wearing surface on the deck, and this has proven very effective.

The piers, at the foot of 31st and 33rd Streets, South Brooklyn, have been in service for about three years. No signs of cracking or other imperfections have appeared, and the piers, as a whole, are a complete success.

Repairs.—For the modern type of concrete deck pier, the cost of maintaining the fender system is about the same as that for the wooden pier; deck sheathing repairs are practically eliminated, except such minor asphalt patching as may be required, and can be considered negligible in a good asphalt deck under cover; the deck plank is eliminated; the life of the ranger and cap system is prolonged by the protection from moisture given by the impervious concrete deck, and the cost of maintenance and repairs, therefore, is reduced to a minimum.

(c) The supporting part, below the water line, is permanent; and

(d) The resulting structure is such that it can be readily extended, reconstructed, or, if necessary, entirely removed at a cost not prohibitive, as would be the case, for example, with most types of reinforced concrete deck-supporting structures.

II. That the department has produced permanent parts in the structures where these are essential. No attempt was made to obtain absolute permanency above low water, in the structure supporting the deck, for the reason that.

III. This portion of the structure, the caps, piles, braces, etc., protected as they are from saturation by urine and other objectionable fluids by the concrete and asphalt deck forming a protecting roof, can be maintained in good condition at a very low cost.

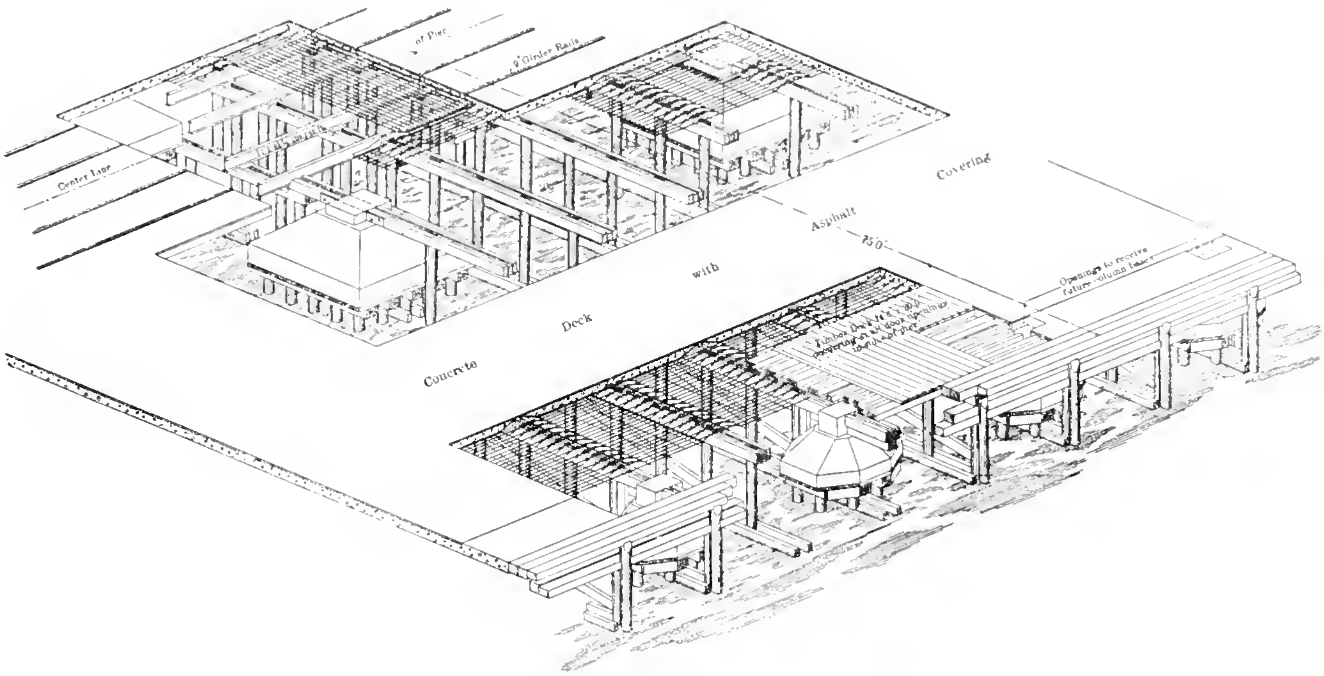


Fig. 6.—Showing Placing of Steel Reinforcement, Pedestals, Track Beams, Etc., New York Pier Construction.

Conclusions.—From the foregoing it will be observed that the problem which confronted the department was the elimination of the timber deck and deck-supporting structure of the wooden pier, by the substitution therefor of some permanent form of construction meeting the following requirements:—

(a) Economy in cost of construction and maintenance, the unit cost to be such as to produce or make possible a remunerative return on the capital invested.

(b) The construction to be of such character as to be readily extended, reconstructed, re-modeled, or, if necessary, entirely removed, as more intensive development of the area occupied by the pier or system of piers might be made necessary by the growth of commerce and shipping.

From what has been stated the following conclusions may be deduced:—

I. Admitting that timber piles and foundation work are generally permanent below the mean low water line in New York Harbor, the Department of Docks and Ferries has met the requirements of the problem by producing piers having the following characteristics:—

(a) The deck is absolutely permanent;

(b The substructure, above mean low water, is easily and cheaply repaired and maintained;

IV. The type of structure produced, approximating permancy, is now being built by the department at a first cost no greater than that of the former type of wooden pier throughout, and the cost of repairs and maintenance of the deck structure is almost entirely eliminated.

SELECTION OF SAND FOR CONCRETE.

The two most essential qualities to consider in sand are cleanness, that is, freedom from impurities, and coarseness of the grains. The sharpness of the grains and the mineralogical composition, according to "Concrete Costs," by Taylor and Thompson, while affecting to a slight extent the strength of the mortar for concrete, are not in themselves sufficient for accepting or rejecting a sand.

Cleanness, meaning by this not so much freedom from fine, clayey material as freedom from vegetable matter, is of prime importance, since such impurities may so affect the strength of the mortar as to make even a well-graded sand absolutely dangerous to use. The fineness of the sand and its percentage of silt passing a sieve having 100 meshes per linear inch, may also be a ground for rejection, since a fine sand always makes a weak mortar or concrete.

DETERMINATION OF WATER IN COAL.

By P. L. Teed.

At first sight the determination of water in quantities of coal would appear to be a simple operation in the hands of the assayer, and because of its simplicity one would expect great accuracy in the operation. In a paper read at a meeting of the Institute of Mining and Metallurgy, Mr. Teed makes clear, however, that the task does not admit of such accuracy as one might suppose. In his paper he endeavors:—(1) To show that in the simple drying method universally employed for determining the percentage of moisture in a fuel, reactions other than the simple volatilization of the water take place, which may materially affect the accuracy of the result, and (2) to describe an accurate and rapid though more complex process for determining the percentage of moisture in fuel. The method universally employed is that of taking a weighed quantity of 80-mesh coal, drying the same in a steam oven, and recording the loss in weight, but sources of inaccuracy exist due to the following reactions:—(a) Oxidation of pyrites making the result too low, (b) volatilization of matter contained in the coal making the result too high; and (c) oxidation of the coal itself making the result too high.

The following method has been evolved:—The apparatus, consists of a 100-cc. pressure flask, a "U" tube, of about ½-in. bore, and a sulphuric-acid drying tube, all of which must be capable of withstanding atmospheric pressure; besides these, sound rubber corks and some form of vacuum pump are necessary. With regard to the latter, the Sprengel water vacuum pump worked off the main supply has been found to give a reduction in pressure equal to about 725 mm., and to be in every way satisfactory.

The employment of the apparatus is as follows:—In the dry weighed flask a quantity of finely divided coal (80-mesh) is placed, and the weight of the same determined by difference; this flask is connected to the weighed "U" tube, whose limb nearest the flask is filled with lump quicklime, while that more remote is filled with finely-ground quicklime; this "U" tube is connected to the sulphuric acid drying tube, which is itself joined up to the Sprengel pump with an intervening tap. The pump is started and a vacuum gradually created (the speed of the outcoming gas being shown by the bubbles in the sulphuric acid drying tube); the flow of water through the pump is gradually increased, until a vacuum of about 700 mm. is created; then boiling water is poured into the beaker in which the flask containing the coal is standing, while to the beaker in which the lime tube is situated, a boiling aqueous solution of either sodium chloride or calcium chloride is added, care being taken that the corks of the tube are not wetted with the solution. The reactions taking place are as follows:—

Under the reduction of pressure and at a temperature of the boiling water surrounding the flask containing the coal, the water in the coal, together with volatile matter varying with the nature of the coal, distils off and passes into the lime tube where, in accordance with the following equation—

$$(CaO + H_2O - Ca.OH)_2,$$

the water originally in the coal is chemically retained, while the other volatile matter from the coal, owing to the absence of any chemical affinity for the lime, and the higher temperature of the lime tube (due to its being surrounded by a boiling aqueous solution of sodium chloride or calcium chloride), passes through to the sulphuric acid drying tube, where some of it is retained, discoloring the sulphuric acid, while other portions pass through to the pump.

At the end of about half an hour, the whole of the water having passed from the coal to the lime tube, the tap adjoining the vacuum pump is turned off, the beaker of boiling water surrounding the coal flask is removed, and the air gradually let back through the sulphuric acid drying tube into the apparatus; then the apparatus is taken to pieces, the lime tube washed, wiped, placed in a desiccator to cool, then weighed, the increase in weight noted (this increase is solely due to water from the coal) and the percentage of water in the coal calculated.

In the new method the two errors due to oxidation no longer exist, because the water is distilled from the coal in the absence of air, and consequently no oxidation can take place; with regard to the error due to volatilization of matter in the coal, something more must be said, for the volatilization still takes place, but since the temperature of the quicklime tube is higher than the coal itself, no condensation can take place in this tube unless chemical action takes place.

When determining the percentage of moisture in an anthracite, it was found that the increase in weight of the drying tube was greater than the loss in weight of the anthracite in the coal flask, by an amount far greater than would be accounted for the fact that the aqueous vapour in the air originally in the apparatus would be absorbed by the drying tube; naturally it was at first supposed that there must be some leak in the apparatus between the coal flask and the drying tube, but this, on performing a blank experiment, was not found to be the case.

The experiment was repeated, using anthracite in the coal flask, and it was found that while the increase in weight of the drying tube was equal to 2.78 per cent. of the anthracite employed, the decrease in the weight of the anthracite in the flask was equal to 2.52 per cent. This curious fact having been undoubtedly established, the author sought for some explanation of it, and could but conclude that when the water left the coal under the influence of the reduced pressure and heat, it left it in the physical condition of charcoal, capable, like charcoal, of absorbing many times its own volume of gas.

PRODUCTION POWER PLANTS.

The United States Bureau of Mines has published a study of the producer-gas plants using anthracite. Such a plant has large conservation and commercial possibilities. Government experiments for eight years have demonstrated not only a very low fuel consumption per horse-power hour, but also the possibility of utilizing commercially low grades of bituminous, lignite and peat.

There are in present use engines with aggregate capacity of 200,000 horse-power deriving this power from producer gas. Engines with power from blast furnace and coke oven gas aggregate 350,000 horse-power. The latter type is largely in steel works, the power being used for mills and furnaces.

There are producer-gas plants in 46 states, the District of Columbia and Alaska. From 1909 to 1912 such plants increased from 474 to 722, or 52 per cent. Horse-power increases from 11,250 to 187,140, or 68 per cent. Plants using anthracite increased from 415 to 610 and their power from 48,100 to 89,470; those using bituminous from 37 to 77 and power from 54,150 to 86,605; those using lignite from 23 to 32 and power from 9,000 to 10,230.

The producer-gas power plant has proved economical in obtaining power and in using fuels such as peat and lignite. Texas in 1912 had 28 producer-gas power plants, of which three used bituminous coal, six used anthracite and 19 used lignite.

CONCRETE CULVERTS.

By F. H. McKechnie, B.A.Sc.

(Continued from last week, p. 827.)

The Old Rail Culverts.—The old rail culvert is not one in very general use, but is used, more or less, as a substitute for the regular reinforced beam or arch culvert. The Oregon Short Line Railroad uses box and arch culverts reinforced with steel rails.

In the box culverts the rails in the cover plate are spaced close together under the tracks and further apart towards the ends. The rails are all set base downward and the side walls are well battered to give wide footings.

In the arch culverts the rails are laid alternatively base and head downwards and are bent as nearly as possible to the shape of the arch. The spacing of the rails is the same as that for the box culverts. Under the centre, where the spacing of the rails is closest, two parallel strips of expanded metal are embedded on the intrados. The side and wing walls are braced together by cross walls of concrete, thus holding the filling of gravel or rocks in the invert.

The concrete used in the culvert is mixed in the usual proportions of one, three, six for such structures, Portland cement and broken stone being used.

I-Beam Culverts.—This is a type of culvert quite extensively used on the Canadian and American railroads, and is particularly used and useful where a wide culvert opening is necessary on account of a low elevation of grade above stream bed and where a large waterway is needed.

The accompanying figure (Fig. 9) shows a construction adapted for culverts, cattle passes, drainage ditches, etc., ranging from ten to fifteen-foot spans. The arches are usually quite flat, the twelve-foot arch having a radius of sixteen feet for a chord of twelve feet and corner curves of two-foot radius to the face of the abutment, which has a batter of one in twenty-four.

Fig. 9.—Typical Railroad Culvert With 10-Foot Opening.

For single track the length of the culvert is nineteen feet, and twenty feet and a half over the parapet walls. The thickness of the concrete at the crown of the arch is eighteen to twenty-three inches and five lines of ten to twelve-inch I-beams, sixteen feet long, spaced two feet apart, are placed under each track, embedded in the arch with about three inches of concrete below and eight inches above at the crown.

The upper surface of the arch is made to form, with the parapet walls, a basin or trough in which the ordinary ballast is laid, thus allowing the roadbed to be continued unbroken over the structure. The wing walls may be built straight or flaring, as desired. The invert is laid with a twenty-six-foot radius and scouring may be prevented by apron walls at the ends.

The culvert shown is one of this type with a ten-foot opening, and contains about one hundred and ninety yards of concrete.

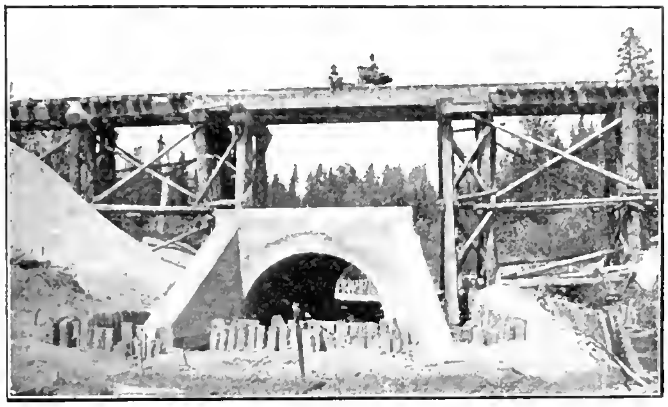


Fig. 10.—Typical Railroad Culvert in Earlier Stage of Construction.

The Box Culvert.—Flat slabs for culverts resting directly on the abutments are used in spans of from four to sixteen feet. Box culverts for railroad work are similar to highway culverts, but must be built to carry the greatly increased loading coming upon them. The side walls are usually reinforced so as to withstand earth pressure due to dead and live loads. When the abutments are sufficiently heavy at the base for this wall, it may be designed as a simple slab supported at top and bottom. Thus the walls may be greatly reduced in thickness over what is required for a wall of plain concrete.

It is frequently, depending on the material on which the culvert is built, necessary to carry an inverted slab continuous between the side walls to provide ample bearing for the heavy loads coming on these foundations. When such a floor slab is used it should be of the same strength as the cover slab, with the bars inverted in the top of the slab. Wing walls, when used, may be designed the same as for an ordinary retaining wall.

In calculating moments in box culverts of this type, a live load is assumed of 50,000 pounds on axles, five-foot centres, and 10,000 pounds per foot of track. This load may be taken as distributed uniformly over ties eight feet long The manner in which the live load will be distributed when it reaches the culvert cover will depend on the character of the embankment.

It may be assumed that the line of zero stress in the embankment, due to live load, follows a slope of one-half to one, which is much more nearly vertical than the ordinary angle of repose. For fill of less than two feet, the impact allowance should be one hundred per cent., between two and four feet, seventy-five per cent.; above four feet an allowance of fifty per cent. may be made.

Let P_L = unit pressure on cover per square foot due to live load.

Let P_D = unit pressure on cover per square foot due to dead load.

Then $P = P_L + P_D$

Total load per linear foot = 10,000 pounds, and adding 50 per cent. for impact = 15,000 pounds.

$$15{,}000 = P_L \left(\frac{8 + h}{2}\right) \text{ or } P_L = \frac{30{,}000}{h + 16}$$

$$P_D = 100h$$

$$P = \frac{30{,}000}{h + 16} + 100h = \text{total superimposed load per}$$

square foot on cover.

The beam culverts similar to those described are often used where the arch culvert might just as well be employed. The argument most often advanced by advocates of the beam culvert, as compared with the arch, is increased waterway. Other possible advantages are a simplicity of arrangement of false work and a greater ease of analysis. Taking up this last argument, while it is admitted that the reinforced beam is a comparatively simple structure and the arch a very complex one, it will be shown, nevertheless, that there is no such advantage, since an arch designed by the very same method is the stronger of the two.

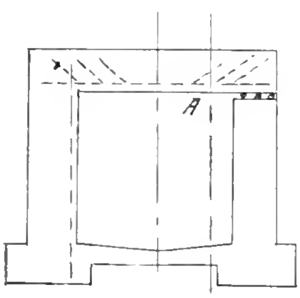


Fig 11.

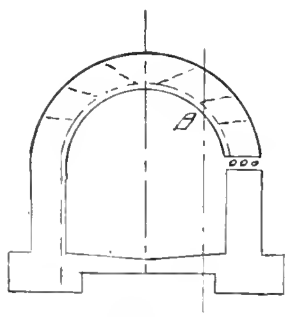


Fig. 12.

Fig. 11 shows a flat top culvert of usual design, consisting of a concrete beam, reinforced with steel tension members embedded near the lower edge, and shearing members arranged diagonally near the ends, supported on reinforced concrete abutments with the bed of the stream paved with concrete.

It is an easy matter to determine the proportions of such a beam required to carry a given load, the beam being a comparatively simple structure from a mathematical standpoint.

Fig. 12 represents an arch having the same span and height of opening and reinforced in a similar manner and with the same thickness of material at any point in the span.

A comparison of the two designs, the properly designed beam culvert of Fig. 11, and the arch culvert derived from it in Fig. 12, shows that the arch culvert is far the stronger and more efficient design, although by no means a properly designed arch.

Assume both beam and arch supported on rollers, so as to be absolutely free from all horizontal forces and unable to offer any resistance to horizontal thrusts. Now, with the same loading on the two structures, the bending moments at any given point of the span are the same for both. Thus the bending moment at A, of the beam is the sum of the moments of all forces to the right of that point. The same is true of the bending moment at the point B, of the arch, since all the forces are vertical and equal in both structures. The bending moment is balanced by the moment of resistance of the section, which is greater in the arch at every point except the crown, where it becomes equal to that at the middle of the beam. At any vertical section other than the crown, the compression is slightly greater in the arch than in the beam, but the tension and shear are less, and at no point of the arch is the compression greater than at its crown, which, like the middle of the beam, is the weakest point in the structure, neglecting shear. In shear the arch has a very decided advantage over the beam, as the section is very much increased at the region of maximum shear. We have, then, the remarkable deduction that a very badly designed arch, not even capable of resisting horizontal thrusts, is as strong as a properly designed beam, having the same section and reinforcement.

If we take both structures under practical conditions, all pressure back of the abutments tends to weaken the beam culvert, by increasing the compressive stresses in the upper fibres of the beam.

No provision can be successfully made in the beam for contraction or expansion.

In the case of the arch, all pressure back of the abutments adds to the strength of the structure, since it sets up moments counter to those produced by the vertical loads, thus tending to reduce the bending moments at the weakest sections. Every inch of upward curvature in a beam culvert increases its strength.

Design of Arch Culverts.—The variations in the design of arch culverts have considerable effect on the cost and efficiency. To combine the least cost with the greatest efficiency, the following conditions should be considered:

(1) The amount of masonry.

(2) Simplicity in the work of construction, forms, etc.

(3) The design of the wing walls.

(4) The design of the junction of the wing walls with the head walls.

(5) The safety and permanency of the structure.

These conditions are more or less antagonistic to each other, but to obtain the best results in design a proper proportion must be reached between the opposing conditions

Arch culverts differ only in size from ordinary arches except that the invert is frequently paved.

A common method of connecting the wings to the abutments is to make an angle of fifteen to thirty degrees away from the axis of the arch and to build them up with the usual batter and thickness. The angle of the wings may be determined by the natural conditions, such as rate of stream, ice conditions and material back of wings.

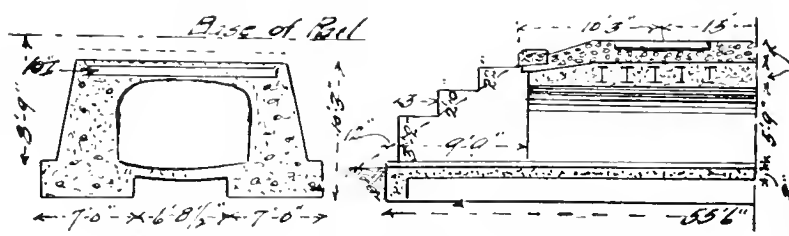


Fig. 13.—Embedded I-Beam Culvert.

To give the best entrance to the culvert for the water and ice, the wings should be carried up to the springing line of the arch flush with the inside face of the abutment and with the same batter. This leaves an entrance to the culvert perfectly smooth, and without corners in which ice or timber might block.

For small concrete arches, plain, from five to fifteen feet in span, they are generally semi-circular arches. For twenty to thirty feet, segmental arches offer some advantages; for the same length of intrados a little wider span is given, the area of the waterway is a little greater, for the same length of span there is a little less masonry. The segmental arch, on the contrary, requires ten to twenty-five per cent. greater thickness of arch ring and abutments.

Trautwine gives the following formula for the depth of keystone:

$$\text{Depth of key in feet} = \frac{2\sqrt{\text{radius} + \text{half span}}}{4} + .2 \text{ feet.}$$

This is for cut stone. For concrete the result should be increased by one-eighth.

Rankine's rule for crown thickness is:

$$\text{For single spans} — 2\sqrt{.12 \text{ radius}}$$

The crown thickness may also be found approximately by first determining the approximate crown thrust. This may be found by obtaining the centre bending moments for all loads, as for a beam, and dividing by the rise. The proper value for crown thrust is that one producing equilibrium about the point of rupture.

Trautwine's rule for determining the thickness of abutments for arches, in feet, at the springing line, for any abutment, the height of which does not exceed one and one-half times the thickness at the base is: The required

$$\text{thickness} = \frac{\text{radius in feet}}{5} + \frac{\text{rise in feet}}{10} + \text{or} - 2 \text{ feet.}$$

The radius used is that of a circle passing through the two springing lines and the crown, on the soffit.

This formula is applicable to a semi-circular, segmental, or elliptical arch. This thickness is given to resist the thrust on the wall, arising from the earth pressure of the embankment of any height, over and around the wall.

Where the earth only extends a few feet above the top of the arch, it is evidently safe to consider the half arch, with its abutment and weight above, as the equivalent of a vertical faced wall of the height of the embankment, and find the thickness of the wall to insure stability, as in retaining walls, or using the thickness followed in practice, that is, from two-fifths to one-half the height. Any greater height of embankment would probably not require any greater thickness of abutment wall. The great stability of the wall, resulting from increase of weight of material above, would balance the increased thrust.

A more extended discussion is impossible on account of the very involved character of such a discussion.

The following method of designing semi-circular arches of reinforced concrete, for spans up to fifty feet and with not more than ten feet of fill over crown is suggested by Dan. B. Luten:

$$\text{Crown thickness} = \frac{\text{span}}{30} + \frac{1}{3}.$$

The outer to be drawn with the centre one-tenth of the span below the centre of the inner circle. The back of the abutments tangent to the outer circle and battered one in four.

The square inches of steel required to reinforce one edge of the arch for one foot in width to be $\frac{HL}{400{,}000C}$.

Where H is the height of the opening in feet.
C is crown thickness in inches.
L is the live load in pounds that can be concentrated in single track, over half the span.

Reinforcing of Culverts.—These remarks will apply chiefly to the semi-circular arch culvert, as they are practically the only culverts built without reinforcing of any kind.

Anyone at all familiar with the condition of the arch culverts along our railroads is aware of the only too common occurrence of cracked concrete culverts.

The most frequent cause of failure is the unequal settlement of the foundations under the two ends of the structure, causing ugly, disfiguring cracks at right angles to its longitudinal axis and, indeed, often noticed extending across the intradosal face of the arch. Similar cracks often occur in the invert. Another type of crack much in evidence is one running longitudinally along the centre line of the invert where the arch usually has the least thickness, indicating unequal settlement of the sidewall foundations.

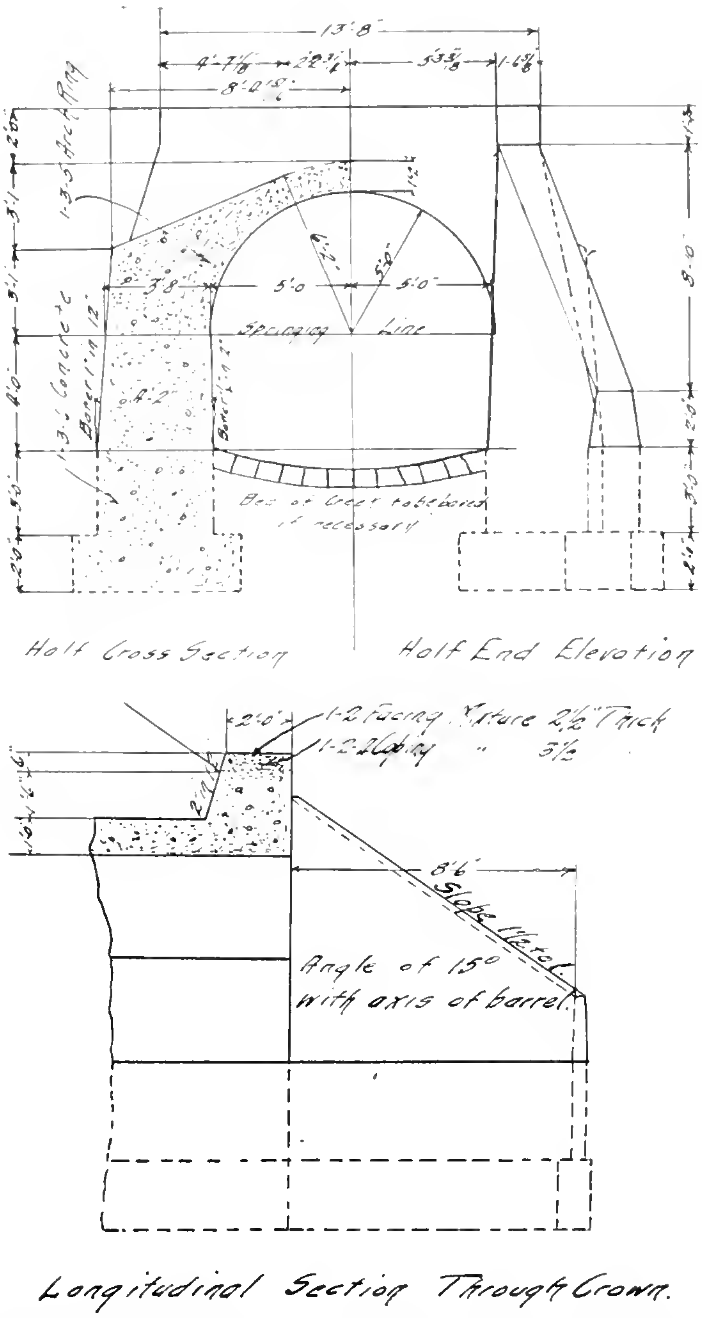


Fig. 14.—Standard (N. T. Ry.) Semi-circular Arch, 10-Foot Span.

Contraction and expansion from changes of temperature, as well as shrinkage stresses, have also been known to have caused cracks in concrete culverts, but these causes of failure are not so common as unequally yielding foundations.

If the culvert is properly reinforced, such conditions as those described above do not occur because the culvert will act as a monolith. The culvert will be capable of beam action and cracks will not appear so readily as in a plain concrete structure, thus far greater durability is assured.

Such a culvert will stand up under more severe conditions imposed by traffic and nature than one not reinforced, and if both were subjected to the same test the reinforced structure would remain intact for a much longer period of time.

Semi-circular arch culverts are in very common use in Canada, without reinforcing. They are used almost entirely

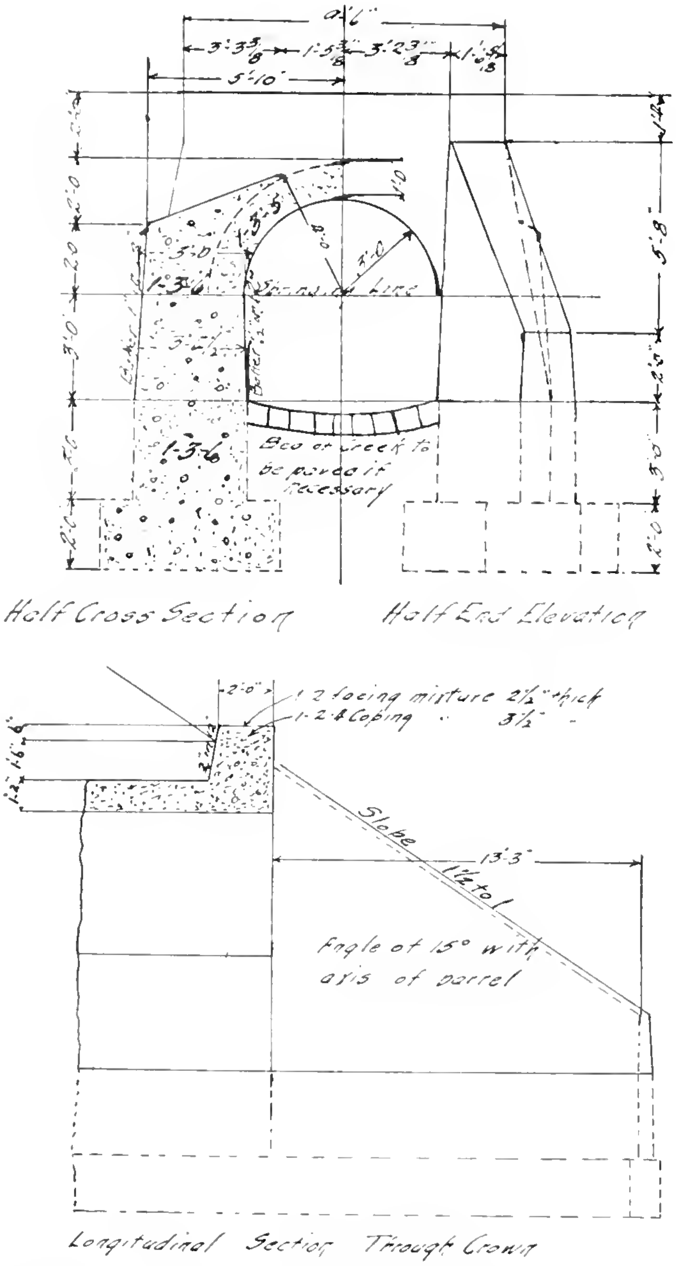


Fig. 15.—Standard (N. T. Ry.) Semi-circular Arch, 6-Foot Span.

by the National Transcontinental Railway and a good example of their abuse is shown there. The standard designs for ten-foot and six-foot spans are shown in Figs. 14 and 15. These culverts are put in, in the majority of cases, without any reinforcing whatever and with foundation conditions far from ideal. Piling is driven, but in a great many cases there is such a large body of poor clay material overlying the solid stratum beneath, that the piling receives very little lateral support, and so, when the fill is made and the pressure comes on the back of the abutments the piling gives away laterally causing longitudinal cracks in the arch. This condition may be prevented by putting in a solid floor of concrete, reinforced diagonally with twenty-pound rails, so as to form a grillage. This enables the culvert to withstand the lateral pressure and the uneven settlement, if it is not too pronounced. With the arch reinforced as well the culvert is practically insured against failure.

The character of the failures in these culverts is well shown in a report compiled by Mr. C. R. Young, B.A.Sc., on a number of the culverts in District "B" of the National Transcontinental Railway. This report shows that about seventy-one per cent. of the culverts on the report show cracks.

The only conclusion that can be arrived at from a view of Mr. Young's report is that all culverts of greater span than five feet should be reinforced, and that provision should be made for expansion joints in those of long barrel.

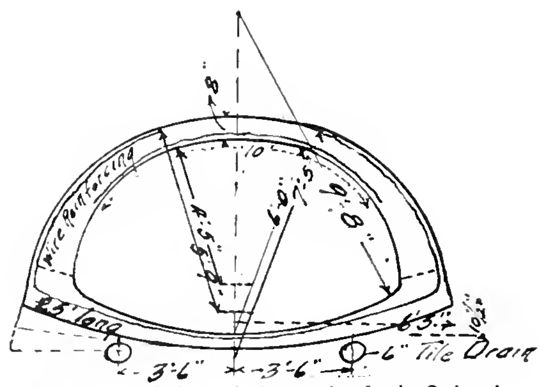


Fig. 16.—Reinforced Concrete Arch Culvert.

Below is given a description of a reinforced concrete arch culvert built at Kalamazoo, Michigan. This is shown in section in Fig. 16.

The culvert is one thousand and eighty feet in length, with a clear width of nine feet ten inches and clear height of six feet. Its grade is from 0.4 to 0.5 per cent. The masonry is entirely concrete, composed of sand, gravel and Portland cement in the general proportions of about one part of Portland cement to six parts of sand and gravel. Actually the upper arch was made with a little stronger mixture and the lower arch a little weaker. Anywhere there was likely to be a little extra pressure a richer mixture was used, under street crossings and where the underlying soil was particularly treacherous.

For reinforcing, a woven steel wire was used. The members of this fabric extending around the culvert were No. 11 steel wire and two layers of the fabric were used, making a total length of wire surrounding the culvert of 175 feet per linear foot. The dotted lines in the figure show changes in the shape of the bearing portion of the concrete, according to the earth on which the culvert is laid. Under parts of the culvert, resting on quicksand two lines of tile drains are laid under the invert to remove the excess water. When drained, it became firm and a good foundation. Before backfilling, interior and exterior of the arch surface were well brushed with neat cement grout.

Costs of Culvert Construction.—Eighteen-foot, semi-circular arch.

The culvert was built under a trestle sixty-five feet high before the trestle was filled in.

The foundation being such that piling was necessary, the railway company drove piling to support a concrete foundation two feet thick and a concrete paving twenty inches thick. The barrel of the culvert was one hundred and forty feet long, but no expansion joints were provided. Cracks developed later, about fifty feet apart, due to the lack of provision for expansion.

The contractors were provided with a large quantity of quarry spalls which had to be crushed by hand. The stone was shipped in drop bottom cars and dumped into bins built on the ground under the trestle. The sand was shipped in ordinary coal cars and dumped into bins. The mixing boards were placed on the surface of the ground and wheelbarrow runways were built up as the work progressed.

The cost of 1,900 cubic yards of concrete in the culvert was as follows, per cubic yard:

1.01 bbls. of Portland cement	$2.26
0.56 cu. yds. of sand @ 60c.	.32
Loading and breaking stone	.25
Lumber, centres, cement house and hardware	.64
Hauling materials	.04
Mixing and placing concrete	1.17
Carpenter work	.19
Foreman (100 days @ $2.50)	.13
Superintendent (100 days @ $5.50)	.29
	$5.29

Only 19 yards per day of concrete were placed, with a gang of 21 negroes @ $1.10 per day. The item for superintendence is high.

Cost of concrete pipes, previously described in this article. The cost of molding the four-foot concrete pipes is estimated as follows:—

Two per cent. of $40 for forms	$ .80
Assuming that a single set of forms can be used only fifty times before being replaced.	
1.1 cu. yds. stone and screenings @ $1.85	2.04
0.8 bbl. of cement @ $2.10	1.68
10 hours' labor @ 28c.	2.80
	$7.32

This gives a cost of $1.83 per linear foot of pipe, of $7 per cubic yard of concrete.

The cost of transporting and installing concrete pipes, on account of greater weight and a greater number of pieces, would probably be very nearly double that for cast iron pipe. However, it is evident that the cost of a concrete pipe culvert in place would be but a small fraction of the cost of cast iron pipe culvert of the same diameter, if the haul is only a moderate distance.

SAVING OUR FORESTS.

"Constant progress in forest conservation" is the keynote of the fourteenth annual report of the Canadian Forestry Association, which has just been issued from the office of the secretary, Mr. James Lawler, Canadian Building, Ottawa. The report, which contains all the addresses made by the prominent forestry experts, legislators and officials at the convention held in Victoria, B.C., is replete with the latest views of the most advanced minds in this line of national public activity. The great strides forward of the Federal and Provincial Governments, two of whom passed far-reaching legislation within the year, unusual progress of the science of forest protection among lumbermen, and the numerous changes in the Canadian Forestry Association itself, all indicate most clearly that the country is rapidly taking up the issue and making for more adequate protection of the great forest heritage. Copies of the Canadian Forestry Association report are to be had free, from Mr. Lawler, on application.

AUTOMATIC SPRINKLERS AND HOTEL FIRES.

The question of fires in hotels in the United States is receiving a great deal of attention just now, and many publications are taking up this hazard not only with respect to loss of the building, but to the lives endangered nightly. The average fire occurrence in hotels during 1912 was one to every thirty-three hours, and during 1913 so far the hotel fire rate has been one every thirty hours. It is stated that eighty-five per cent. of the fires occur between six o'clock p.m. and six a.m.; almost fifty per cent. between midnight and three a.m.; twenty-five per cent. between three a.m. and six a.m., and fifteen per cent. between 9 p.m. and midnight. Hotel fires, it says, were more frequent in 1912 than any of the preceding five years, and so far the increase for 1913 has kept up. The statement is also made that for a period of five years the property loss is estimated at more than $25,000,000, with heavy loss of life.

CANADIAN FORESTRY ASSOCIATION.

The fifteenth annual convention of the Association will be held in Winnipeg, July 7th, 8th and 9th, 1913.

This meeting should be of vital interest to all Canadians who are interested in the conservation of Canada's natural forest resources. Canada's forest area is about 800,000,000 acres, containing some six hundred billion board feet of merchantable timber, worth in the neighborhood of ten billion dollars. But Canadians are cutting this timber at a rate of about 100 board feet per acre, or eight billion board feet per year; the fire loss is estimated to be 950 board feet per acre per annum, which means that these fires are destroying young growth, forest litter and soil fertility on hundreds of thousands of acres That there is a crisis coming is apparent to all—when the forests which for a century men have thought inexhaustible are going to be greatly depleted.

This emergency must be prepared for by stopping the waste in logging, milling and utilization, the destruction of timber by insects and fungus, and protecting the forests from fire. At present Canada spends much less than one cent. per acre per annum on the forest lands under management, and only a fraction of this absolute forest area is growing trees as it might be, the rest being comparatively unproductive. How can Canadians stop the losses, arrest the waste? There is but one answer. Public opinion, public interest, and public conscience are the only forces that will ever make for progress. At the convention a number of practical papers will be read and discussed of problems relating to the great central part of Canada. These will include that of protection and perpetuation of the forests of Western Ontario, and of northern Manitoba, Saskatchewan and Alberta; the best methods of handling prairie forest reserves, and the possibilities of the same in supplying timber, fence posts, poles and cordwood for the settlers; the need of getting under timber the sand lands, which will never produce any other profitable crop but trees, and the rate of growth in the central parts of Canada as a basis for deciding the possibility of economical forestry under these conditions. These will be accompanied by the discussion of the value of forests as windbreaks, sources of stream supply, and as cover for insectivorous birds. Farm forestry, shelter belts to protect buildings and orchards, and the use of hedges will be discussed, as will also the dangers from insects and how these may be dealt with.

COAST TO COAST.

Victoria, B.C.—If plans which a joint committee of the Victoria and Saanich councils are considering are carried out, a magnificent highway along Shelbourne St. to Mount Douglas Park will be constructed. The thoroughfare undoubtedly would be one of the best in the city, and by connecting the city with one of the finest spots in this section would prove an attractive addition to the already numerous beauty spots of which the city and adjoining territory boast. Plans of the proposed improvement have been under preparation for some time and were submitted at a joint meeting of represeutatives of the two councils. These plans show a roadway leading from Bay Street out to and around Mount Douglas, the entire length being approximately three miles. To fully improve this roadway by constructing sidewalks, boulevards, pave an eighteen-foot roadway on either side with a double tramway line in the centre would, it is estimated, cost in the neighborhood of $240,000. To construct only the pavement portion at present would cost approximately $150,000. The city has for some time been contemplating improvements to the Mount Douglas Park. The location is remarkable for its natural beauty and the magnificence of the view to be obtained therefrom. With a thoroughfare such as is suggested Shelbourne Street would be made the connecting link between the city and the park, and the attractions for visitors would be greatly increased. To raise the necessary funds the city and Saanich would have to take the money from general revenue or submit by-laws to their respective ratepayers. But until it is ascertained to just what extent the Government is prepared to go, the financial aspect of the matter will be allowed to stand.

Winnipeg, Man.—The city of Winnipeg has under consideration the expenditure of $14,000,000 towards bringing a supply of 25,000,000 gallons of water per day from Shoal Lake. The estimate is based upon two pipe lines, the first of which would require four years in building. The construction of the second, requiring a time of like duration, would be proceeded with upon completion of the first and would be, generally speaking, an auxiliary line. A gravity system will be used. City Engineer Ruttan submitted an alternative estimate on a combined gravity and pumping system which would cost in the neighborhood of $11,500,000 for construction, but would entail an annual expenditure for maintenance exceeding the gravity system alone by approximately $168,000.

Quebec, Que.—A new electric water-leak alarm is being installed on ocean vessels. It includes a series of small iron boxes screwed at several different heights to the bulkhead of each compartment. Each box has an electric device connected to a convenient indicator-board, which is fitted with small glow-lamps of different colors, and is in circuit with an electric bell. As water reaches the lowest iron box, electrical contact is made, the lamp corresponding to the lowest level lights up, and the bell rings until switched off. The lamp remains lighted as the water rises to the second box, switching the current to the second lamp, or until the receding water is below the lowest contact, breaking the circuit.

Ottawa, Ont.—The final report of the Bradbury committee on the pollution of navigable streams was tabled by the the chairman, the member for Selkirk, on June 2. The report recommends that the government arrange, during the recess, for a conference of representatives of each of the provinces, of the International Waterways Commission and the chairman, Mr. Bradbury, to discuss the whole problem "with a view to overcoming local difficulties and agreeing upon some form of remedial legislation which could be passed concurrently by the Dominion government and the provincial legislatures." The committee also recommends that it be re-appointed at an early period, next session, with a view to carrying to completion the work now begun. The report states that Dr. Hodgetts, of the Commission on Conservation, has been asked, while in England this summer, to inquire as to the latest methods of sewage disposal in the old country, and to obtain furthur information as to sewage and water conditions.

Toronto, Ont.—The work of opening up tne northern territory by the construction of good roads goes on apace. J. F. Whitson, the man who is spending the $5,000,000 granted for the development of New Ontario, points out his progress in a recent report to Hon. W. H. Hearst, minister of lands, forests and mines. Gangs of several hundred men are scattered through the north laying out highways. Great progress is being made, especially in the Rainy River district. "Six camps on road construction have already been established in the Rainy River country employing 80 men, and within the next week or two, 100 to 125 men will be at work in this district," says Mr. Whitson. "By the end of June this number will be doubled." A very large section of land, which is badly in need of additional roads, will be opened up for settlement this year. Road making in Rainy River is very easy compared with other districts. Roads can be made at a reasonable cost as a result of the fires which swept over the country in 1894 and three years ago. A few camps will be started soon in Thunder Bay. Four camps have already been established in Sudbury, and a large force of men is at work. Work in Nipissing is well under way with about 100 men employed. In Timiskaming a number of camps have been started between Englehart and Matheson, and between Matheson and Cochrane.

Montreal, Que.—W. G. Ross, president of the Harbor Commissioners, and M. P. Fennell, secretary of the Board, left Montreal last week to visit the numerous lake ports, where they will go carefully into the grain handling facilities on the Great Lakes. The party will visit Fort William, Port Arthur, Duluth, Tiffin, Port McNicoll and other ports where grain is handled in large quantities. Messrs. Ross and Fennell will also interview the larger grain exporters of Western Canada with a view to having them ship their grain through Canadian ports and especially through the port of Montreal, in preference to the American ports which are now enjoying a large part of the Canadian business. It is expected that as a result of this trip, a large portion of the business now going through American ports will be diverted to Canadian channels, as the only reason local officials can give for this business going to the United States is that the people of the West are not familiar with the facilities which the Canadian ports offer.

Moose Jaw, Sask.—Official announcement was made recently by Hon. Robert Rogers, Minister of Public Works at Ottawa, that the Government had decided to erect two interior storage terminal elevators at Moose Jaw and Saskatoon, to have a capacity of three to four million bushels each and to cost in the neighborhood of a million dollars. The locations for the elevators for Alberta have not yet been decided upon but in all probability the first will be at Calgary. In addition to these interior storage elevators the Government has decided to erect a big transfer elevator on the Pacific coast, which will be owned and operated by the Government in order to handle the grain business which it is expected will flow west by the Pacific when the Panama Canal is opened. A Government-owned terminal elevator of large capacity will also be built at Port Nelson to handle the wheat

which will go north by the Hudson Bay route and this will be ready by the time the line reaches the seaboard. There has been provided in the supplementary estimates four million dollars so that work can be proceeded with at once. Orders have already been given to the Grain Commission, under whose supervision the new elevators will be built, to proceed at once with work on the Moose Jaw and Saskatoon elevators. Both these cities have offered free sites and it is likely the offers will be accepted. The Commission will select the sites at once. The new elevators will be thoroughly modern in every respect, will have full inspection equipment and also hospital equipment for the drying of grains. They will have a capacity of three to four million bushels and will cost in the neighborhood of a million each. As soon as locations are settled in Alberta, work will be started there also. The commission will, it is expected, visit the Coast this summer and make arrangements for the new Pacific Coast elevators. The building of these elevators, it is believed, will do much to solve the difficulties of the annual blockade and transportation problem which faces the western farmer yearly. Hon. Robert Rogers has been particularly interested in this question and has given a great deal of attention to the subject and that the Government is going ahead with the scheme on a large scale is due to the efforts of the Minister of Public Works.

St. Catharines, Ont.—With an expenditure of $50,000,000 planned for the next five years in the deepening of the Welland Canal, there will be an activity in the counties through which this waterway passes that will in some respects rival the work on the big canal across the Isthmus of Panama. Tenders are being called for the construction of the first sections of the work, beginning at the Lake Ontario end. The route to be followed has been settled definitely. It is to follow the Valley of Ten Mile Creek from Lake Ontario, crossing the present canal below lock No. 11 at the level which now exists there, the rise having been effected by three isolated locks with suitable pondage areas intervening. This level is carried through to the foot of the escapement below Thorold, which is overcome by three locks in flight and a single lock on the upper level, in the town of Thorold. Beyond Thorold the level of low water in Lake Erie will be held to Port Colborne, the present canal route being generally followed except between Port Robinson and Welland River. It is proposed to utilize the Welland River and at a point near Humberstone where the present sharp bend will be done away with by a cut-off. The guard lock will be built in this cut-off and will be utilized to protect the canal from the high water of Lake Erie. How great an improvement the new canal will be over the old may be gauged from the fact that instead of 27 locks, as at present, there will be but seven. The scheme is to build the locks 800 feet long by 80 feet wide, with capacity for 30-foot draft, though the canal will not at present be built with a draft of that amount. The reason of this is that the Soo has not yet the 30-foot draft. When it has the Welland will be deepened, but the same locks used. One of the questions that had to be met in planning the new canal was how the Welland River would be crossed by the canal at the town of Welland. On this point Hon. Mr. Cochrane stated to the House that the engineers recommend turning the river into the canal. The minister expressed the opinion that to do this would mean a saving of money and the towns would be helped out, too, by bringing the water supply from the lake. There will be no final dedecision, it is understood, until the towns have been heard from. These towns are Welland, Thorold, Merritton and St. Catharines. The conference to be held with them by the Government will settle the proportionate part of the cost which each of these municipalities should pay to secure fresh water from Lake Erie in the construction of the large pipe line contemplated.

Montreal, Que.—City Engineer Janin has submitted his report to the Board of Control on the measures necessary for the improvement of conditions in Montreal's street car service. This marks the first step toward the betterment of conditions. Mr. Janin's report contains the following important suggestions: The elimination of all unnecessary stops; the placing of switchmen at every important junction point; teaching passengers to have their fares ready; the installation of larger and clearer signs on cars; the relief of congestion in the rear part of cars; the prohibition of the hauling of freight in day time; better supervision of traffic at junction points; doing away with delays at the central office; the prevention of "short-turning" of cars at the option of the conductor; the installation of autobus lines to supplement the tram-cars. Mr. Janin, in his report, has made no recommendations which will entail any large expenditure either by the Tramways Company or the city, and his report cannot be taken as a final solution of the street car problem.

PERSONAL.

D. ROSS, B.A.Sc., is assistant to Mr. Malm, electrical and traction engineer, Toronto Railway Company.

MR. J. E. RITCHIE, B.A.Sc., has accepted a position with the Toronto Iron Works, Toronto, as designing engineer.

CHARLES H. CLAPP, of the Canadian Geological Survey will become a member of the School of Mines faculty at the University of Arizona at the beginning of the next year.

MR. H. H. COUZENS, the new manager of the Toronto Hydro-Electric System, arrived from England last week, but will not take actual charge of the system till July 1st.

MR. L. W. RUNDLETT, at present city commissioner of Moose Jaw, Sask., has been appointed city engineer. This position will be in conjunction with that of city commissioner.

MR. NORMAN K. HAY has been appointed city engineer of Sydney, N.S., to succeed Mr. Campbell. Mr. Hay has been construction engineer with the Dominion Iron and Steel Company.

MESSRS. P. W. ST. GEORGE, J. A. JAMIESON and F. A. BARBOUR have been appointed by the city council of Montreal to report on the nature of the site selected for the filtration plant.

T. KENNARD THOMSON, consulting engineer, of New York City, was in Toronto on Friday last. He attended the commencement ceremonies of the University in Convocation Hall and received the degree of Doctor of Science (Honoris Causa).

S. A. WOOKEY, H. M. STEVEN and V. H. EMERY are directors of the Dominion Mineral Exploration Syndicate, with main offices in Kingston, Ont. Mr. Wookey is field engineer. All three are graduates in mining engineering of the University of Toronto.

HON. THOMAS TAYLOR, Minister of Public Works for the province of British Columbia, has been appointed to represent the Government of British Columbia at the annual meeting of the International Good Roads Congress, which commences June 23 in London, Eng.

MR. JOHN SPROAT, for 35 years road superintendent of Delta, has retired from that position. At a recent banquet which Premier McBride attended Mr. S. A. Fletcher, govern-

ment agent, pointed out the fact that during his long career Mr. Sproat had built and located 800 miles of road, 300 miles of trails, and 300 bridges.

OBITUARY.

MR. JOHN BRECKENRIDGE died at Calgary, Alta., at the age of 52 years. Deceased was born in Ayrshire, Scotland, in 1861, and removed to Peterborough, Ont., in 1867, where he received his education. He was one of the best known and most successful contractors in Canada, having had charge of many important undertakings, notably the C.P.R. irrigation system in that province, which took five years to complete. His firm has also had charge of the C.N.R. construction from Edmonton, Alta., west through Yellowhead Pass to Port Mann. In addition he was connected with many large industrial, mining and other enterprises.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W. Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St., Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase, Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. H. W. Claudet, S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE. —Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

The Canadian Engineer

An Engineering Weekly

METHODS OF RAPID SAND FILTRATION

GENERAL DESCRIPTION OF SYSTEM — COAGULATING CHEMICALS FOR CLARIFYING RAW WATER—OPERATING DEVICES—COST OF CONSTRUCTION AND MAINTENANCE*

By GEORGE A. JOHNSON, M. Am. Soc. C.E.

RAPID sand filtration first attracted attention as a method for purifying public water supplies in 1885, when a rapid filter plant was built to treat the supply of Somerville, N.J. Since that time this method has come into use in more than 350 cities in different parts of the world and supplies a total daily demand of considerably over 700,000,000 gallons. The largest plant of this type is installed at Cincinnati, Ohio, and has a daily capacity of 112,000,000 gallons. Others are located at Columbus, Ohio, capacity 30,000,000 gallons daily; Hackensack, N.J., capacity 24,000,000 gallons; Harrisburg, Pa., capacity 20,000,000 gallons; Little Falls, N.J., capacity 32,000,000 gallons; Louisville, Ky., capacity 36,000,000 gallons; Toledo, Ohio, capacity 39,000,000 gallons; and New Orleans, La., capacity 40,000,000 gallons. Among the larger rapid filter plants under construction in 1911, were those at Minneapolis, Minn., daily capacity 39,000,000 gallons, and at Grand Rapids, Mich., daily capacity 16,000,000 gallons.

Of the three score rapid filter plants in foreign countries the largest is that at Alexandria, Egypt, capacity 12,000,000 gallons daily. Similar works of even greater capacity are under construction at Kyoto, Japan, and at Cairo, Egypt.

The essential differences between rapid sand filters and slow sand filters are as follows: In the rapid sand filters, the filter units are much smaller; the sand grains comprising the filter bed are much coarser; a coagulant is always used in preparing the raw water for final filtration; the rate of filtration is in round numbers forty times that ordinarily used in slow sand filters; and the whole filter bed, when dirty, is cleaned in the tank itself by forcing water upward through the sand instead of scraping off the surface layers as in slow sand filters.

Up to 1902 rapid sand filters were of more or less uniform design. They were contained in wooden or steel tanks of comparatively small diameter, and the more economical concrete construction had not as yet been attempted. At the commencement of the classic investigations into this process of water purification, conducted at Louisville, Ky., under George W. Fuller, in 1895-1898, even the process itself had not proved its usefulness in the purification of large volumes of water. Provisions for adequate preparatory treatment of the raw water were rarely made, and the whole subject of the suitable design and operation of such works was but little understood.

The need of adjusting the design of rapid filter plants to meet local requirements began to be fully realized when the plant at Little Falls, N.J., was built in 1902 for the East Jersey Water Company. In this plant suitable provision was made for the accurate application of the coagulating chemical (sulphate of aluminum) to the raw water. A basin of adequate size was provided in which coagulation and sedimentation of the raw water could take place. The filter tanks themselves were built of concrete, for the first time, and were rectangular in plan. Improved facilities were installed for agitating the sand layer with compressed air during washing. Neat operating tables, from which all valves could be operated and motors started and stopped by hydraulic power, took the place of the less neat and convenient wheel stands. With the Little Falls plant the modern ideas of proper design for rapid filter plants began to be realized, and its construction marked a most important epoch in municipal water filtration.

Nearly all rapid filter plants are now built of concrete, although wooden and steel tanks are still used for small installations. The filter tanks are ordinarily built monolithic, and embedded in the floor of the tanks is the underdraining system, composed of perforated pipes or strainer cups, designed to permit the filtered water to pass out without allowing sand to escape and to permit an even distribution of water throughout the sand layer when the filter is being washed. Over the strainer system a shallow layer of coarse sand or gravel is placed, and on this rests the sand layer which forms the filter proper.

When the raw water has been sufficiently clarified by coagulation and sedimentation it is passed on to the surface of the filter, over which water ordinarily stands to a depth of several feet, and allowed to pass downward through the bed at a rate of 100,000,000 to 120,000,000 gallons an acre daily, such rates being automatically controlled by special devices. This corresponds to a rate of 2,310 to 2,760 gallons a day on 1 square foot of filtering surface.

The water applied to the filter always contains a considerable amount of coagulated matter, such as mud, vegetable stain, and bacteria, which is retained at or near the surface of the bed. As operation is continued the frictional resistance in the sand layer increases to a point where it is necessary to close the filter for washing. At such times the water standing over the bed is drained down to the level of the overflow gutters, which are located a foot or more above the sand layer, and filtered water is then forced upward through

* Extracted from United States Geological Survey Report, 1913, "The Purification of Public Water Supplies."

the filter, being evenly distributed by means of the strainer system. The material which has accumulated on the top of the sand is thus washed out, and the dirty wash water overflows into the gutters, thence to pass to the sewer. Such a washing operation ordinarily consumes about 10 minutes from the time the filter is closed down until it is again thrown into service.

The rapid filters just described are the type more commonly used: they are known as "gravity" filters and are contained in open tanks.

There is another type, known as "pressure" filters. Such filters are contained in closed steel shells. This type of filter is more extensively employed for household and industrial use, and in some places it is found to be more economical and convenient than the gravity filter. The largest municipal plants of the pressure type are located at Davenport, Iowa, capacity 9,000,000 gallons daily, and at San Diego, Cal., capacity 5,000,000 gallons daily.

Coagulating Chemicals.—The chemicals most commonly used for the coagulation of water are compounds of aluminum and iron, and of these potash alum sulphate of alumina, alumino-ferric, and sulphate of iron are the most extensively employed.

The manufacture of alum is of great antiquity, and for many centuries this chemical has been used in far eastern countries for coagulating water as an aid to clarification. The manufacture of aluminum sulphate from bauxite and alum clay is of more recent origin. The process of making alumino-ferric from bauxite was patented by P. and F. M. Spence in 1875. The sulphate of iron used in water coagulation is for the most part a by-product of iron and steel industries.

The choice between the different coagulating chemicals is properly based on their efficiency as coagulants, and this refers directly to the percentage of available aluminum or iron which they contain. Potash alum, sulphate of aluminum, and alumino-ferric cost about 1 cent a pound; sulphate of iron costs about half a cent a pound. In this country sulphates of aluminum and iron are the most widely employed in water purification, but at the waterworks at Tokyo, Japan, potash alum is used. Sulphate of aluminum is the coagulant in the works at Alexandria, Egypt, and also in practically all rapid filter plants in Europe, India, and Egypt, except at the waterworks at Calcutta, India, where alumino-ferric is used.

In composition these chemicals show considerable variation, but they may be bought on a basis of a guaranteed percentage of available alumina or iron oxides. The essential feature is that the chemical shall be basic, that is, shall contain more aluminum or iron than the equivalent of the sulphate radicle present. The approximate composition of these chemicals now on the market is as follows:

Approximate Percentage Composition of Coagulating Chemicals.

Constituent.	Pure potash alum	Sulphate of aluminum	Alumino-ferric	Sulphate of iron
Matter insoluble in water	.....	0.30	0.06	0.50
Alumina (Al_2O_3)	10.77	17.00	14.26	.....
Iron oxides (Fe_2O_3 and FeO)	.....	.25	.60	57.50
Potash (K_2O)	9.93	.....	.....	.....
Sulphur trioxide (SO_3)	33.76	38.70	35.81	28.80
Water (H_2O)	45.54	43.75	49.27	13.20

When potash alum, sulphate of aluminum, or alumino-ferric are applied to a turbid water the chemical is rapidly decomposed. The strong sulphate radicle of the chemical displaces the weak carbonate or bicarbonate radicle in the water, and an equivalent amount of carbon dioxide is liberated. The white, insoluble, and gelatinous aluminum hydrate that is formed absorbs the dissolved color and envelops and brings together into comparatively large aggregates the mud and the bacteria in the water. These flocks of coagulated matter are removed with comparative speed by subsidence.

Generally speaking, the application of these coagulating chemicals to a water will bring about a slight increase in the amount of incrustants in the water and a decrease in temporary hardness. The total hardness of the water—that is, the sum of the temporary hardness and the incrustants expressed in terms chemically equivalent—will remain unchanged. The increase in incrustants has some significance as regards corrosion of uncoated iron and incrustation in boilers; but, practically speaking, these are factors of comparatively little importance in view of the relatively small amounts of the coagulating chemical ordinarily employed.

Most surface waters naturally contain more than sufficient carbonate and bicarbonate radicles to make possible complete decomposition of the chemical which is applied for coagulation. In some waters, however, the natural alkalinity is so low, particularly at times of floods, that this is not true, and for such waters it is necessary to make up the deficiency by applying soda ash or lime water before the coagulant is added.

Sulphate of iron, known commercially as copperas, is obtained in two grades, namely, the ordinary commercial by-product from iron and steel manufacturing, and the higher-grade sugar copperas manufactured by a vacuum crystallizing process.

The use of copperas in water purification introduces more complicated features than alum compounds, chiefly for the reason that lime is required for the precipitation of the iron. When added to a natural water the copperas is decomposed somewhat like alum except that the formation of the hydrate of iron takes place very slowly. By adding lime in the form of limewater or milk of lime rapid formation of insoluble iron hydrates is induced. In general terms it may be stated that to obtain satisfactory results from the use of lime and iron as coagulants it is necessary to make use of sufficient lime to neutralize and precipitate the iron. The use of too little lime results in poor coagulation, caused by the incomplete precipitation of the iron, some of which is usually left in solution and appears in the effluent of the filters. The use of too much lime results in the formation of lime incrustants, which deposit in the air and strainer systems and cause much trouble through clogging.

Water treated with lime and iron will show an increase in permanent hardness, as compared with the effect of the use of compounds of aluminum. In general the aluminum salts are considered more satisfactory as coagulants: they remove color from water more rapidly and completely and make it possible to obtain by filtration a more brilliant water than do iron rails.

Devices for Application of Coagulants.—No department in a filtration plant is more important than that wherein the coagulating chemicals are applied to the water. To obtain satisfactory results from the plant as a whole and the filters in particular, it is necessary that the application of the coagulating chemicals be at all times under strict and accurate control and be adapted to the quality of the water to be filtered. Material variation in the dose of the chemical applied to the water or in the quality of the water means overdosing or underdosing. The former results in a waste of the chemical and sometimes in undecomposed coagulant in the filtered water, and the latter results in incomplete coagulation and impaired efficiency. Owing to the high rates of filtration used in rapid filters undercoagulated water will

leave the filter in a less purified state and will possess an undesirable turbidity. The filter will run longer without washing because of the slower accumulation of coagulated material, but the efficiency will be poor.

The different types of device for the control of the application of chemicals are very numerous and are all designed to be as nearly automatic as possible. The appliances which have given the best results are those wherein provision is made for the application of the solution under a practically constant head through an orifice which can be adjusted at will. The depth of solution over this orifice should not be less than 6 inches, and this depth may be maintained by allowing slightly more of the solution to be delivered into the orifice tank than is allowed to escape through the orifice, the excess being discharged back into the main solution tank through an overflow, or by means of a float valve. The overflow is by all odds the more reliable.

The sulphates of iron and aluminum have a corrosive action on almost all metals, and it has been found advisable to make all of the metal parts which come in contact with the solutions of lead, copper, or special bronze. It is sometimes found advantageous to use hard rubber piping, valves, and orifices, but the cost may preclude the use of such material. Rubber piping and valves are easily broken, and the cost of replacement may prove no inconsiderable item. Generally speaking, however, the decision as to the kind of metal to use depends on the relative cost of the cheaper iron and its correspondingly higher cost for repairs and replacements and the ease with which repairs can be made, and the higher first cost of more expensive materials and the lower cost for upkeep.

Improved Devices for Filter Operations.—As already pointed out, it was not until 1902 that marked improvement was made in the direction of making easier the manipulation of valves and other apparatus, which has so much to do with the successful and economical operation of a rapid-filter plant. Until that time all valves, without exception, were opened and closed by hand. When a filter required washing, it was necessary to close the influent and the effluent valves, and to warm up the steam wash-water pump preparatory to supplying wash water to the filter. Now the operator moves a lever at an operating table, and by means of hydraulic cylinders valves are opened or closed with practically no manual effort or loss of time. Electrically driven wash-water pumps have largely supplanted the steam pumps, and the operator starts and stops this pump merely by pressing a button at the same operating table. Air compressors, which supply air to the filters during washing for the purpose of agitating the sand layer, have in most large plants taken the place of the steam-driven rotary agitators, and these compressors are also started and stopped by pressing a button on the operating table.

As time savers these various improvements more than pay for themselves, and the neat appearance of the newer plants is a vast improvement over the older plants with their multitude of wheel stands.

Filter Washing.—When a rapid filter has become so clogged with coagulated matter that the normal rate of filtration can no longer be maintained, the influent valve is closed and the water standing over the sand layer is drawn down to the top of the wash-water gutters. The effluent valve is then closed and the wash-water pump is started. This pump forces filtered water up through the sand layer until it is freed of practically all of the accumulated matter. The pump is then stopped, the influent and the effluent valves are opened, and filtration is resumed. In some places the filters are washed by water delivered under the requisite pressure from an elevated tank.

During the process of washing a filter it is the practice in the majority of the newer rapid-filter plants to break up the sand layer with compressed air before turning in the wash water in order to facilitate and accelerate the cleaning of the sand grains. In some places, as at Cincinnati, Ohio, and New Orleans, La., no provision is made for agitating the sand layer during washing other than such agitation as induced by the upward flow of wash water. In the older plants, and in some of those recently built, wherein the filter tanks are circular in plan, the sand is agitated during washing by means of rake teeth attached to arms which revolve, driving the teeth through the sand.

When washing a filter the rate of application of wash water must not be too low, and on the other hand it must not be too high, or sand will be carried from the bed with the wash water. Ordinarily the best rate of application of wash water is about 6 to 8 gallons to the square foot a minute, which corresponds to a vertical rise of about 1 foot a minute.

This is equivalent to three to four times the rate of filtration. When wash water is driven upward through a filter bed of normal construction at these rates, the sand layer will rise from 3 to 5 inches, but practically no sand will escape from the bed except during the early stages of operation of a new filter.

Before the modern appliances for facilitating the labor of operation were installed it was not unusual for periods out of service for washing as great as 30 minutes to be recorded, and frequently the time consumed was even longer. In the more recent filters this period rarely exceeds 10 minutes from the time the effluent valve is closed until it is again opened.

Control of Rate of Filtration.—If uniform rates of filtration are required for the successful operation of slow sand filters, then uniform rates are of even greater importance in rapid sand filters. The reason for this is plain. Slow sand filters are operated at actual rates of about 3,000,000 gallons an acre daily; rapid filters are operated at rates from 30 to 40 times as high as this. A sudden fluctuation in these higher rates means a correspondingly greater shock, and impaired efficiency naturally follows.

Although within certain limits there is no particular objection to the rate of filtration in a rapid filter gradually diminishing, a sudden increase in rate will cause an almost immediate deterioration in the appearance and hygienic quality of the effluent. If the rate increases or decreases slowly and steadily no harm may result, but should the rate increase abruptly, even as much as 20 per cent., the effect of the change will usually be apparent from the inferior appearance of the filtered water.

Therefore, to maintain a constant rate of filtration in the rapid filter, automatic controllers are always used. There are many such devices, but the object of all it to maintain a uniform rate of discharge from the filter independent of the head on the outlet pipe on which the controller is located. Although many improvements in these devices have been made in recent years, the best of them subject the filter to fluctuations in rate of at least 10 per cent. Furthermore, on account of the tendency of floats and butterfly valves in these controllers to stick, such fluctuations may occur within a very few seconds. In drawing up specifications for controllers it is frequently stated that such variations from the normal rate shall not exceed 2 per cent., but this requirement is rarely if ever met. Nevertheless the controllers do practically the work required of them, and without them a rapid filter would be unable to maintain a high standard of efficiency.

Cost of Construction of Rapid Sand Filters.—It is almost as difficult to state the comparative cost of construction of rapid sand filters as of slow sand filters. Local conditions largely govern, and it is possible and feasible to build some plants much more cheaply than others, and at the same time obtain plants which will prove as efficient as those which are more complete and ornate. A summary of the more prominent installations and their cost indicates that unless some unusual features are encountered, as in the filters at Little Falls, N.J., where the flow throughout is entirely by gravity, compelling the use of relatively expensive deep structures, or the abnormally large preliminary settling basins at Cincinnati, the cost of a rapid-filter plant, exclusive of high-lift and low-lift pumping equipment, will be about $12,000 for each million gallons daily capacity. On the basis that the water consumption is 125 gallons per capita daily, the first cost to each consumer of such a plant would be about $1.50. At 6 per cent., the interest charges on such an investment would be 9 cents per capita annually.

The above-mentioned fixed charge on the cost of construction of rapid-filter plants is materially lower than that of slow sand filter plants, as would be expected. As a general proposition, it is not usually thought necessary to build large sedimentation reservoirs in which the raw water may be first settled before the coagulating chemical is applied and the water is allowed to flow into relatively small coagulating basins. Where turbid waters are to be purified by slow sand filter plants, large sedimentation reservoirs must be provided or preliminary filters made a part of the system in order to remove the bulk of suspended matter, which would speedily clog the slow sand filters and make the cost of operation of such filters unnecessarily high. The preliminary treatment factor has a great deal to do with increasing the first cost of construction of slow sand filter plants, and, furthermore, the much greater area of filtering surface required for these filters also explains why it costs so much more to build them. It must be borne in mind, however, that all figures of cost herein given are not to be considered as strictly comparable, but only as examples of what has actually been obtained in the construction in this country of filters of the slow sand and the rapid types.

Cost of Operation and Maintenance of Rapid Sand Filters.

Range of Cost.—In the cost of operation of rapid sand filter plants the size of the plant and the quality of the raw water are the main controlling features. Privately owned works are usually operated at lower cost than are those owned by municipalities. As a general proposition, however, the total cost of operation and maintenance of rapid sand filter plants, exclusive of the interest on investment and pumping charges, ranges in this country from about $3 to $5 for each million gallons of filtered water. For some plants the cost is even less than $3, and for others it is in excess of $5 for each million gallons. The following examples will show the cost of operation of several plants in this country.

The Little Falls plant is filtering about 30,000,000 gallons daily. The charge for superintendent and labor includes the salaries of the superintendent, one filter foreman, four filter attendants, an analyst, and a boy. On a basis of a yield of 30,000,000 gallons daily, the cost of operation for each million gallons of water filtered is as follows:

Cost per Million Gallons of Water Filtered at Little Falls, N.J.

Labor	$0.80
Coagulant	1.43
Heat	.35
Power	.22
	$2.80

No itemized costs of operation of the plant at Binghamton, N.Y., are available, but it is understood that the total cost is about $6 for each million gallons of water filtered.

During 1910 the Harrisburg filters were operated at an average rate of slightly over 9,000,000 gallons a day. The cost of operation for each million gallons during 1910 was $5.31 and was divided up as follows.

Cost per Million Gallons of Water Filtered at Harrisburg, Pa., in 1910.

Labor	$2.52
Coagulant	1.06
Supplies	.28
Repairs	.38
Coal	.63
Oil and waste	.07
Laboratory	.37
	$5.31

During the year 1910, which was a representative year, the average yield of the Cincinnati rapid-filter plant was 49,000,000 gallons daily. The total cost of operation and maintenance was $4.19 for each million gallons of water filtered, the charge being made up as follows:

Cost per Million Gallons of Water Filtered at Cincinnati, Ohio, in 1910.

Supervision and attendance	$1.98
Coagulant	1.93
Repairs	.28
	$4.19

Total Cost of Rapid Sand Filtration.—It has been stated above that the average cost of rapid sand filter plants is about $12,000 for each million gallons daily capacity, which cost will include the necessary filter building, the filters, and the coagulating and filtered-water basins. At 6 per cent. this cost corresponds to a fixed charge of about $2 for each million gallons. The addition to this charge of a fairly average figure for operation and maintenance makes the total cost of filtered water by the rapid sand filter system, exclusive of pumping charges, about $6 for each million gallons. On the basis of 125 gallons per capita daily consumption, the total cost of water filtration will be, according to these figures, about 27 cents per capita per annum. This estimate is approximate and is subject to considerable variation according to the conditions in various places. It is obvious that the larger the filter plant the lower will be the cost of operation per million gallons; and also that where waters require a great deal of coagulating chemical the cost of operation will necessarily be increased in proportion.

Efficiency of Filtration.—Slow sand filters will render water clear and practically free from turbidity and will remove a material percentage, probably from 20 to 30 per cent., of the dissolved color in waters stained by decaying vegetable matter. They are not able to treat successfully and economically the very muddy waters of the central western and the southern portions of this country unless such waters are first subjected to long periods of plain sedimentation or to shorter periods if coagulants are used. Rapid sand filters are capable of treating successfully practically all kinds of water, but are particularly applicable to the treatment of waters heavily charged with suspended matter or which are highly colored. The final effluent from such filters will contain practically no residual color or turbidity. Both types of filters will ordinarily remove all but about 1 or 2 per cent. of the bacteria originally present in the raw water.

In the following table are given a few representative samples of the efficiency of slow and rapid sand filters in cutting down the typhoid fever rate in communities where they are used. This is one of the best indices to the bacterial efficiency of filters. In addition to the reduction of typhoid fever effected by filters, it appears to be a fact that the death rate of a community is materially reduced by the substitution of a pure for a polluted water supply. At the International Engineering Congress, held at St. Louis in 1904, Allen Hazen made the following statement:[1]

* * * Where one death from typhoid fever has been avoided by the use of better water, a certain number of deaths, probably two or three, from other causes have been avoided. This seems the clear and logical conclusion from the statistics. It is not easy to explain how the water is connected with the deaths other than those from typhoid fever. It may be that a good water supply, used freely and with confidence, results in a better general tone in the system of the population, and so indirectly to a lower death rate, and that a part of the reduction is represented by diseases having no recognized connection with the quality of the water supply.

Death Rate From Typhoid Fever per 100,000 Population in Cities Using Filters.

City	Kind of filter	Plant completed	Years, in average— Before filtration.	Years, in average— After filtration.	Typhoid fever death-rate— Before filtration.	Typhoid fever death-rate— After filtration.
Albany, N.Y.	Slow	1899	10	10	90	21
Binghamton, N.Y.	Rapid	1902	5	5	47	15
Cincinnati, Ohio .	Rapid	1908	4	2	50	13
Columbus, Ohio ..	Rapid	1908	11	2	78	15
Lawrence, Mass. .	Slow	1893	7	15	114	25
Paterson, N.J. ...	Rapid	1902	5	8	32	10
Pittsburgh, Pa. ..	Slow	1907	8	3	133	*26
Watertown, N.Y...	Rapid	1904	5	5	100	38
York, Pa.	Rapid	1899	2	8	76	22

*Filtered-water section. Allegheny not included.

[1] Trans. Am. Soc. Civil Eng., vol. 54 D, p. 153.

A SILICIOUS WOOD PRESERVATIVE.

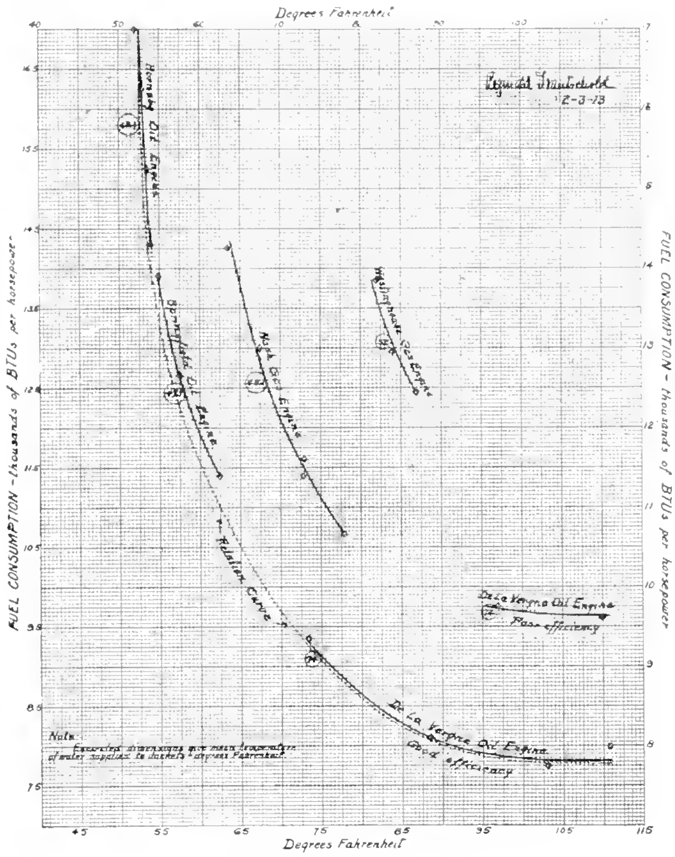
In a new process for the impregnation of timbers with melted paraffin and naphthalene, diatomaceous earth, a silicious material, is ground so fine that ninety-two per cent. passes a two-hundred-mesh screen. This is mixed with the melted paraffin and the naphthalene and timbers immersed in the mixture for four hours. As compared with the twelve to twenty-four hours required in creosoting, this is noteworthy. Furthermore, it is an open vat process. The wood is permeated to the centre and resists the attack of marine borers and decay, besides gaining the resilience. Nails hold better and do not rust, nor does the wood become waterlogged. Hardwoods, like white oak, which resist other treatment, yield to this preservative. The expense is small, for the mixture costs only three cents per pound, and less than two pounds of solution are required for each cubic foot of timber.

When completed, New York's skyscraper, the mammoth fifty-five-story Woolworth Building, will have cost approximately $13,500,000, of which amount $4,500,000 represents the cost of the land, $1,000,000 of foundation excavation, and $8,000,000 for construction.

JACKET WATER TEMPERATURES AND FUEL CONSUMPTION IN INTERNAL COMBUSTION ENGINES.

By Reginald Trautschold, M.E.

The thermal efficiency of internal combustion engines, the proportion of the heat units supplied that are converted into available or useful kinetic energy at the fly wheel—is, and has been, high as compared with that of even the most efficient types of reciprocating steam engines. And one of the main reasons of the recent wide adoption of the former type of engine to service of all kinds lies in the fact that its average efficiency, as the engine is to-day manufactured, shows considerable improvement over that of similar engines built but ten or fifteen years ago. This increased efficiency has been obtained through the use of more suitable mixtures in the combustion chamber, better regulation, improved design, and proportions, etc., etc., until at the present time



TEMPERATURE RANGE OF JACKET WATER

CHART I

internal combustion engines operating on crude and the heavier oils have occasionally developed a thermal efficiency of about 35 per cent. Such progress is very gratifying and has helped in the wide introduction of internal combustion engines, but even now many such engines are being operated below their best efficiency from lack of general and proper knowledge of the requirements and conditions governing efficiency. Particularly is this so in the question of jacket water temperatures—water jacketing being generally resorted to in stationary engine practice—and a study of this question is, therefore, of particular interest.

In considering the effect of jacket water temperatures upon fuel consumption, two main points naturally present themselves, 1st, the amount of heat that the jacket water should absorb—i.e., its temperature range, for most satis-

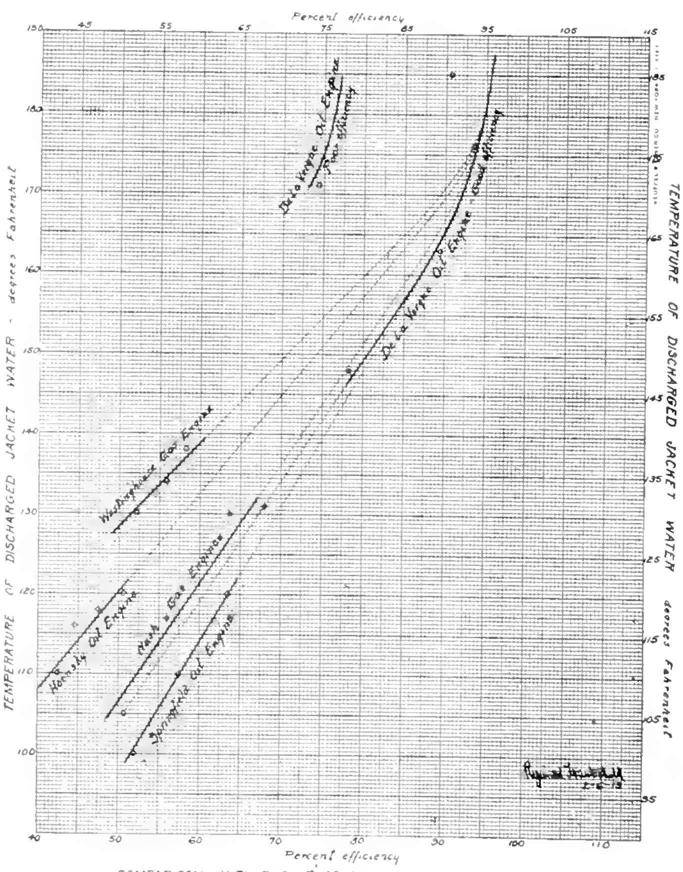
factory operation; and 2nd, the temperature at which the water should be discharged from the jackets. The first consideration governs the amount of jacket water that should be used, as the available temperature range of jacket water supply is inconsequential, when the intense heat of the gases at the moment of ignition is taken into consideration—a point of importance when the jacket water is cooled on discharge from the jackets and used over again, a practice that is nearly universal. The second consideration is but a logical deduction from the first, but it is, nevertheless, upon this point that the economic consumption of fuel or thermal efficiency of the engine largely depends.

Engines operating under all degrees of efficiency must be considered before any conservative and reliable rule can be advanced to govern the supply and temperature of the jacket water that will assure the converting of the greatest proportion of the heat units supplied by the fuel into useful energy. Hence, the data given in Table I does not do justice to the possibilities of the various types of engines mentioned, nor does it properly indicate their relative efficiencies, but is merely a record of the jacket water temperatures of engines operating under various degrees of efficiency.

Table I.

Type of Engine	Fuel and Heating Value	Consumption of Fuel per Horsepower	Jacket Water Increase Range	Temperatures Discharged Water
Oil Engine "A"	Kerosene	17,000 B.T.U.	52.0 F.	110 F.
	20,000 B.T.U.	16,250	53.0	116
	per pound	15,250	53.5	118
		14,300	54.0	120
Oil Engine "B"	Gasoline	13,900 B.T.U.	55.0 F.	100 F.
	18,000 B.T.U.	12,650	57.5	110
	per pound	11,400	62.5	120
Oil Engine "C"	Fuel Oil	9,250 B.T.U.	73.5 F.	148 F.
	19,000 B.T.U.	8,100	88.5	163
	per pound	7,750	103.0	176
		8,000	111.0	185
		9,750	97.0	171
		9,600	110.0	184
Gas Engine "A"	City Gas	14,250 B.T.U.	63.5 F.	110 F.
	560 B.T.U.	13,000	67.5	117
	per cubic foot	11,600	73.0	127
		11,400	73.0	130
		10,650	78.0	131
Gas Engine "B"	City Gas	13,850 B.T.U.	82.0 F.	130 F.
	560 B.T.U.	12,950	84.0	134
	per cubic foot	12,450	87.0	138

The effects of temperature range of jacket water on the fuel consumption are graphically illustrated by the curves of Fig. I, a chart which clearly indicates two important facts. One, that the relation existing between the range of temperature of jacket water and consumption of fuel, for engines operating on fuels of about the same heating value, follows closely the relationship illustrated by the smooth curve designated "Relation Curve" and that about the same relation exists for engines operating on fuels of any specific heating value. Two, that the temperature of the water supplied to the jackets, within usual limits, has little effect upon the efficiency of the engine as far as fuel consumption is concerned. Considering only the engines operating on fuels of about the same richness or heating value, it is seen that the fuel consumption decreases rapidly with any increase in the temperature range of the jacket water for relatively small values of heat absorption by the jackets and that the rate of fuel consumption continues to decrease with increasing temperature range of jacket water, with gradual retardation, until a temperature range of about 105 degrees Fahrenheit is reached, after which the fuel consumption of the engine remains about constant. During this period of minimum fuel consumption, little or no gain in efficiency is obtained by increasing the temperature of the range of the jacket water, and if increased to such a point that the discharge temperature is too high, a point that will be referred to again, serious generation of steam in the jacket will occur, reducing the efficiency of the jacket and upsetting the rule that increased temperature range of jacket water is conducive to reduced fuel requirements. With unusually cold water supply it is possible, of course, to retain the water in the jackets until a considerable range of temperature takes place, but as previously stated the possible temperature range of the jacket water supply is limited and the possible gain in fuel consumption due to increased temperature range of jacket water is hardly sufficient to warrant running the risk of an interference with the water supply that may counteract the small gain in economy of fuel consumption through increased temperature range of jacket water by a too great increase in the



COMPARISON WITH ENGINE OF 35 % THERMAL EFFICIENCY

CHART II.

temperature range of the jacket water to from 100 to 130 degrees Fahreinheit, depending upon the temperature of the water supplied to the jackets, in ordinary installations of internal combustion engines. Engines operating on fuels of lesser heating value, require a greater range of jacket water temperatures to give the same fuel economy as those operating on fuels running about 18,000 or 20,000 B.T.U. per pound but, as in all cases, the temperature range of the jacket water is limited by the temperature at which it is discharged from the jackets, and this is governed by the generation of steam in the jackets.

About the best thermal efficiency for an internal combustion engine that has yet been attained is 35 per cent., or the delivery of one brake horsepower per 7,250 B.T.U. supplied, and for sake of convenient comparison, such efficiency will be considered as 100 per cent. A comparison of the thermal efficiencies of various engines, as represented by the data of Table I, with that of an engine delivering a horse-

power of useful energy per 7,250 B.T.U. supplied, shows that the temperature at which the jacket water is discharged, has a marked effect upon the efficiency of the engine. This is graphically illustrated in Fig. 2 and, though there appears to be considerable variation in the efficiencies of the various engines when the jacket water is discharged at a relatively low temperature, the curves for the various engines all point to a maximum engine efficiency when the jacket water is discharged at a temperature at 180 degrees to 190 degrees Fahrenheit. Above 180 degrees the improvement in efficiency is very gradual, as it is at this temperature that the generation of steam in the jackets usually begins to become serious. With well designed and proportioned jackets, however, the jacket water may be safely retained in the jackets until a temperature of 190 degrees Fahrenheit is reached, but beyond such temperature it is very questionable whether any appreciable increase in efficiency is attainable.

The temperature of the jacket water supply is of secondary importance, as its only effect upon the efficiency of the engine is that the cooler it is the less jacket water is required—that is, the greater the possible temperature range—but as a temperature range of from 105 to 115 degrees Fahrenheit furnishes the maximum economy in fuel consumption under ordinary conditions, no material benefit is derived by having the jacket water supply cooler than 70 or 75 degrees Fahrenheit, other than reducing the mean velocity of the supply through the jackets. This, in the average case were the water is used over and over, is conducive to additional expense rather than to economy, as cooling facilities have to be greater than when the water is returned to the jackets at a higher temperature.

The operating engineer has discovered that certain benefits are to be derived by discharging the jacket water at higher temperature than was formerly considered good practice for the engine tests from which the data of Table I was collected, cover a period of some ten or fifteen years, the tests in which the jacket water was discharged at a relatively cool temperature, having been made in the late nineties while those tests in which the jacket water was discharged at the higher temperatures being of comparatively recent date—all tests having been made according to good practice at the time they were made, and to ascertain the best efficiencies of the engines rather than as studies of the effect of jacket water temperatures.

MEXICAN PETROLEUM OUTPUT.

The development of Mexico's petroleum industry is shown by the following statistics of output of crude oil in the past six years: 1907, 1,000,000; 1908, 3,481,410; 1909, 2,488,742; 1910, 3,332,807; 1911, 14,051,643; and 1912, 16,500,000 barrels.

The Canadian Pacific Railway Company, who have invited tenders for two 600 ft. high-speed Atlantic liners, have placed an order with Denny, Dumbarton, Scotland, for two auxiliary steamers of 375 ft. length.

The International Road Congress, which will be held this year in London, England, June 23rd to 28th, will bring together the leading men from practically every country identified with highway construction and maintenance. This is the third Congress of the kind to be held, and is the first to be held in an English-speaking country. The first Congress was held in Paris, France, and the second in Brussels, Belgium. These Congresses are held every three years.

PRESERVATION OF RAILROAD CROSS TIES.

In rather extensive experiments carried on by the United States Forest Service in the preservation and use of cross ties, the following results were secured and deductions drawn:—

Zinc chloride is an effective preservative for ties subjected to the severe conditions under which the experimental ties were laid, as a result of which 87 and 92 per cent. respectively of these ties were serviceable after seven and one-half years. A fairly heavy impregnation of zinc chloride is advantageous. Treatments by the Burnett and Wellhouse processes, made at Somerville, with two per cent. zinc chloride solutions and average absorptions of 0.35 and 0.33 pounds of dry salt per cubic foot of wood, resulted in only 45 and 47 per cent. respectively of serviceable ties after seven and one-half years' service. Similar treatments made at Chicago with a 4 per cent. solution and average absorptions of 0.42 and 0.57 pounds of dry salt per cubic foot resulted in 87 and 92 per cent. respectively of serviceable ties after the same length of service.

A light injection of creosote apparently adds to the effectiveness of zinc chloride treatments. The Allardyce treatments, made at Somerville, show 81 per cent. of serviceable ties, while treatments made at the same plant with zinc chloride alone show only 45 per cent. of serviceable ties after seven and one-half years. Beaumont oil in combination with zinc chloride also produced an effective treatment.

Treatment with preservatives will not yield good results unless the ties are sound in the first place and the treating is properly done. This is strikingly shown by the treatments of zinc chloride and English creosote. These ties were probably injured by over-steaming during the treatment.

The experiments seemed to indicate that ties treated with zinc chloride suffered more mechanical wear than untreated ties, and from this it would appear that the zinc chloride treatment weakens the wood. This result was also noticed on the creosoted ties, in one experiment, but in another, on ties which had been treated with about fourteen pounds of creosote per cubic foot, examined two years after placement in track, approximately two per cent. were slightly affected with decay, and about twelve per cent. of those treated with zinc chloride, but on inspection of a number of ties which were more or less split, it was found that the exposed portions of the ties appeared thoroughly sound and well treated, and it seems probable that the greater part of them were slightly affected with decay at time of treatment, and only two ties could be found showing any rail wear, and this was so slight as to be negligible.

In general, however, these experiments, carried on with seven different railroad organizations, show that in many cases the life of ties can be doubled or even trebled by proper treatment, but to secure this result, the ties must receive a first-class treatment of a good preservative and must receive a liberal and not a skimping treatment.

Ties with low decay resistance, such as loblolly pine, hemlock, tamarack and beech, if laid untreated, should not be tie-plated, as they will decay before they will wear out, even without the tie plates, and, this being the case, the tie plates are a useless expense and do not prolong the life of the tie. However, the increased resistance to decay caused by proper treatment makes it highly desirable to protect the ties from deterioration from mechanical sources, and this is particularly true of ties with low crushing strength.

Practically all radium-bearing ores mined in Canada and the United States are sent to Europe for the extraction of the radium.

FOUNDATIONS FOR PITT RIVER BRIDGE.

Features of the Location and Requirements—Special Interim Construction for Continuous Use—Progress to Date.

While Canada seems to be experiencing great prosperity throughout the entire country, nowhere does this development seem to be making such rapid strides as on the Pacific Coast. This is apparent to everyone who will glance at the enormous outlays by the older railroads for betterments and easements, and also by the strenuous efforts of several new roads to complete their lines across the continent in order to participate in this prosperity and development.

The Canadian Pacific Railway is spending enormous sums in double-tracking, flattening out curves, cutting down heavy grades, and building many new bridges of a type sufficient to accommodate its rapidly increasing traffic. One of the biggest, and perhaps the most difficult, pieces of work between the coast and the summit of the Rockies, is the foundation for the Pitt River bridge.

The present bridge, which is a single-track structure, has been in use only approximately six years, and already it is incapable of handling the traffic passing over it. In addition to this, there lies between the western end of this bridge and Westminster Junction the new terminal yards of the Canadian Pacific Railway, upwards of half a mile wide and two and a half miles long. These conditions made it doubly imperative, on the part of the railroad, to construct a new bridge capable of handling the increased traffic.

The Pitt River is tributary to the Fraser, and is subject to the rise and fall of the tide, although no salt water reaches this point. The river itself, which joins the Fraser opposite Port Mann, and about six miles above New Westminster, has a depth of water reaching almost seventy feet in many points. It is about ten miles long and drains a large body of water known as Pitt Lake. The maximum current is approximately three miles an hour, and this is upstream. One peculiarity of the river is that, while the current is still setting upstream, the level of the water in the river begins to fall, the outward flow not taking place until the water level at the bridge site has fallen approximately six inches.

The new bridge, which is to be a double-track one, spans the river at a point about two miles above its confluence with the Fraser, and is approximately 1,750 feet in length between the backs of ballast walls of the east and west abutments.

The work divides itself naturally into two distinct classes: One comprising pier No. 1 and piers No. 6 to 13 inclusive, together with the two abutments, which are being constructed by the use of sheet piling cofferdams; while piers No. 2, 3, 4 and 5 are to be put in by means of large caissons, which will be built on land, launched, floated into exact position and there sunk to the river bottom. Through wells, the sand, which comprises the river bottom at these points, will be excavated; and the caisson will be weighted to force it downward. When a sufficient penetration has been obtained and the soil at this point, as indicated by borings and by the actual excavation, is satisfactory, the bottom of these dredging wells will be sealed under water, and concrete allowed to set, when the caissons will be pumped out and the rest of the pier constructed in the manner similar to the methods obtaining on land.

The depth of water at the site of pier No. 2 is approximately 45 feet; the depth at piers No. 3 and 4, approximately 65 feet; while the depth at pier No. 5 is about 35 feet. The depth of water at the other piers gradually diminishes until reaching the abutments, the sites of which are above ordinary

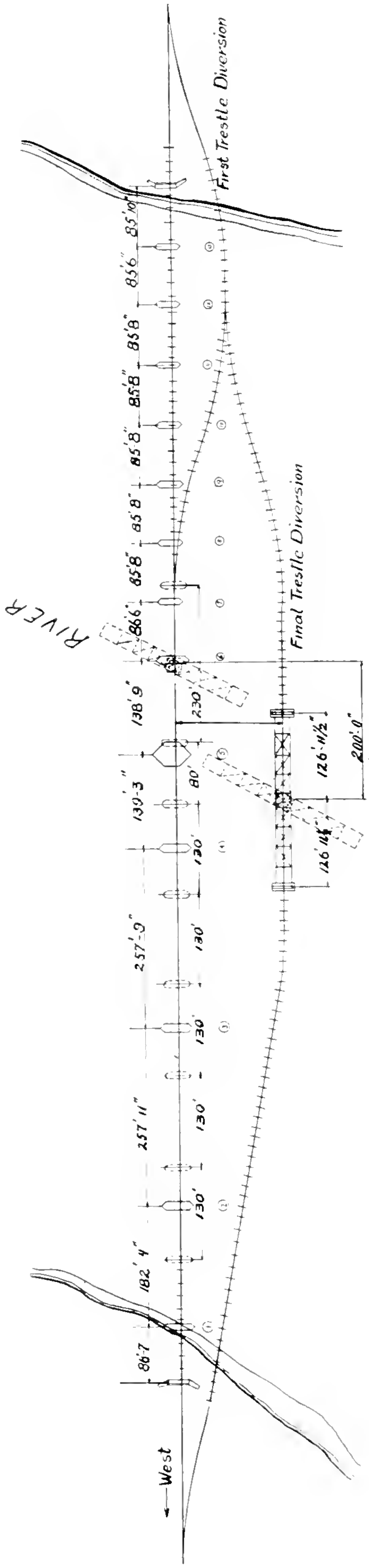


Fig 1.—Layout of C.P.R. Pitt River Bridge, Coquitlam, B.C.

high tide. The river is subject to the annual floods which inundate the banks of the Fraser. At this point on the Pitt, the shores are protected by dykes or levees about 18 feet in height, which is approximating the height of the base of rail of the railway. These annual floods are very irregular in time and occurrence, and also in the elevation to which they rise. There seems to be no possibility of foretelling what the conditions may be, as the snows on the mountains are always sufficient to supply enough water, provided the rise in temperature is sudden and of sufficient duration.

The Foundation Company, Limited, of Montreal, Canada, was called in to do this work, on account of the recognition of the many difficulties anticipated here, and also because this company had successfully handled difficult work of a similar nature in the east for the railway company.

Recognizing the desire for the completion of this work at the earliest possible point of time, operations were begun immediately, no delay for the removal of traffic from the old bridge taking place. The construction of the two abutments and several of the piers was prosecuted while traffic was still operated over the old bridge. At the same time, the railroad company began to construct trestle work across the river, for the purpose of diverting this traffic. The diversion was

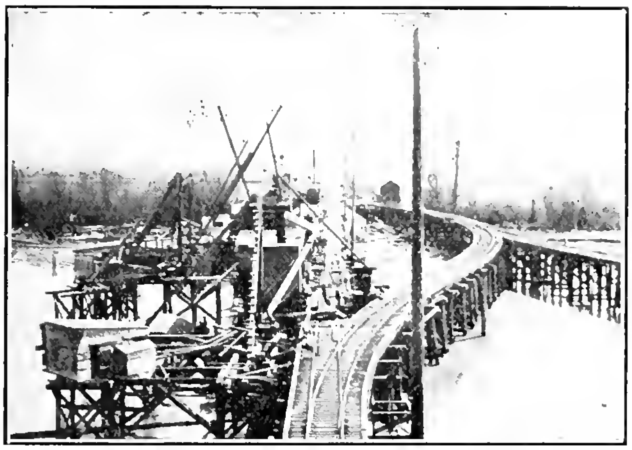


Fig. 2.—C.P.R. Pitt River Bridge, Showing Trestle and Work on Eastern Portion.

a necessity, owing to the fact that two of the old piers had to be demolished, in order to accommodate piers for the new bridge, as well as to shorten the time of construction. This pile trestle is expected to be completed by the end of June. The railroad company is now erecting the truss of the swing span, which was formerly used in the old Red River bridge, where the foundations for a new bridge had been built by The Foundation Company. This swing span for the trestle is being erected on the guard pier, and at right angles to the line of traffic. When this is in operation, the swing span of the old bridge will be floated out of position, and the old pivot pier removed, so that the east rest pier for the new swing may be erected at this point. The west rest pier of the old swing must also be taken out, as the pivot pier of the new bridge will be constructed on its location.

By reference to the accompanying plan, the reader may note the pile trestles built by the railway company to accommodate the diverted traffic, as well as the old piers which had to be removed, and the location of the new piers, with the lengths or dimensions, centre to centre, of the various plate girders and trusses of the new bridge. The work on the new bridge has been pushed forward with all possible despatch; the two abutments and piers No. 12 and 13 having been completed, while piers No. 1, 9, 10 and 11 will be completed early in the month of June. The soil on the west side of the river, where pier No. 1 was constructed, under the old bridge, while traffic was maintained at this point, consists of very compact, rather finely grained sand, rather difficult to

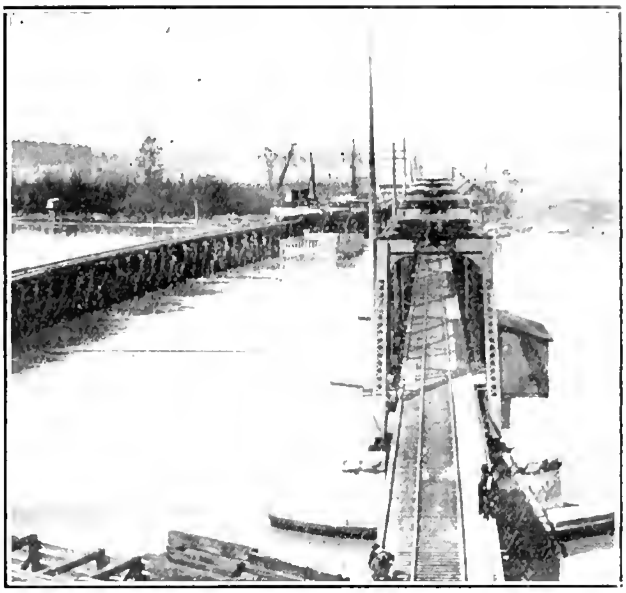


Fig. 3.—C.P.R. Pitt River Bridge, Showing Western Portion of Main Trestle.

handle; while on the eastern bank of the river the soil, which was largely of a clayey silt, contained many pockets of fine, white sand, along with stumps, driftwood, roots and branches of trees, and also layers of dead vegetation, making it, on the whole, a most treacherous class of material. The removal of the stumps loosened up the soil to a considerable depth; the dead wood, which could not be reached by ordinary means, or the presence of which could not be known, shattered some of the sheeting, which had to be pulled and replaced, while the layers of vegetation in this soil permitted the water, when under only a moderate pressure, to penetrate into the excavation rather freely, but all these difficulties either have been or are being successfully overcome.

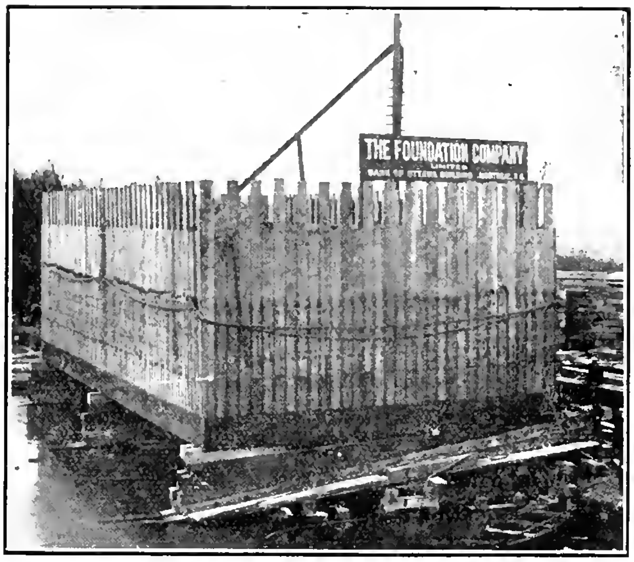


Fig. 4.—C.P.R. Pitt River Bridge Caisson No. 2, Ready for Launching.

The caissons which are to be dredged to proper depth are, roughly, 35 feet wide by 75 feet long, containing two dredging wells about 17 x 20 feet and, when complete, will be over 100 feet high. One of these has already been launched and is ready to be put in position, while the second one is on the launchways and almost ready to be put into the water. These caissons were built to a height of about 12 feet, caulked and otherwise made water-tight, and weighed, when launched, approximately 250 tons, with a draft of 8 feet. Owing to the scour which developed in the river bottom when the old piers were being constructed it was decided that it would be unsafe to place these large piers in position, namely, midway between the old piers, until after traffic was diverted to the pile trestle, so that this part of the work has been confined entirely to the construction of the caissons.

The work is handled by the Vancouver office of The Foundation Company, Limited, under the direction of Mr. J. G. Sullivan, chief engineer, C.P.R.; Mr. H. Rindal, division engineer, and Mr. J. R. Middleton, resident engineer. It is expected that the work will be nearing completion by the end of the year.

GOOD ROADS PROBLEM IN SOUTH VANCOUVER.

With the advent of the automobile two problems were created on the trunk roads in all countries which the various road authorities have since been endeavoring to solve as efficiently and as economically as possible, the abatement of the dust nuisance and the preservation of the surface of the roadway.

The South Vancouver counncil has recently decided upon two steps which, though at first glance do not seem to have any connection with each other, are yet very closely allied. The council has decided to engage the services of a consulting engineer to advise as to the practicability of establishing a municipally-owned gas-making plant on the North Arm of the Fraser River, and they have given a contract to the M. P. Cotton Company to oil five miles of roadways in the municipality at a cost of $175 per mile. The council has also decided to permanently pave Main and Fraser Streets with creosoted wood blocks.

The oiling and the paving propositions have two main objects, the abating of the dust nuisance and the preservation of a good road surface; and, though these two objects would at first appear to have no connection with the proposal to establish a municipally-owned gas-making plant, there is as a matter of fact a very close connection.

Probably in no country in the world are there better trunk roads than those running throughout the length and breadth of the British Isles; and in recent years nearly all of those roads have been treated either with raw coal tar or with some proprietary preparation of coal tar, which, as everyone knows, is a product derived from coal during the process of manufacturing gas.

The method of treatment varies, but whether raw tar is used or the more expensive proprietary preparations, the result of treating a road surface with coal tar is practically the same, a good, solid surface, over which an auto glides with a smooth, even motion, practically dustless, yet impervious to water during wet weather. The only difference is the cost.

Engineers differ in their opinions as to the best method of treating a road surface with coal tar or a preparation of tar. Some assert that the crude or raw tar needs to be refined before using it on the roadways; others declare that the raw tar is by far the best for painting the surface of a roadway, and they are of opinion that better results are obtained from the use of raw tar than from the use of any of the many preparations of tar.

While the road construction engineers are settling the question to their own satisfaction it may be interesting to record the result of an experiment carried out by the municipal engineer to one of the urban authorities on the North Wales coast over a period of five or six years.

The highway between Holyhead and Chester runs through his district, and in addition he has many miles of roadways under his control. The municipal council owns the gas works, and for the past five or six years the engineer has been experimenting with various preparations of tar and with the raw tar as it comes direct from the gas works, for the purpose of treating the roadways under his control; and, as the result of his experiments he has come to the conclusion that the tar direct from the gas works gives better results than any preparation on the market.

The method which the engineer in question has found to give the best results is a very simple and inexpensive one, working out in his case at less than a cent per square yard for the actual spraying and cost of tar after the roadway had been prepared for the treatment.

The first essential for the success of tar spraying is a good, even-surfaced macadamized roadway with a fairly level top: that is to say, with less fall to the sides than would be necessary if the surface was not to be sprayed. After the roadway had been thoroughly rolled the engineer mentioned had the road brushed, thus removing all dust and loose stones and soil. An old water-cart or sprinkler was then taken to the gas works and filled with warm raw tar, and on arrival at the piece of roadway to be treated the tar was sprinkled over the surface in exactly the same way as would be done in sprinkling water to lay the dust, the only difference being that two men followed the sprinkler armed with wide rubber squegees with which they distributed the tar evenly over the surface of the roadway, one-half of which only was treated at once, leaving the other half open to traffic and paths across the tarred half for foot passengers.

Dry weather is the second essential for success in tar-spraying, because two days are necessary to allow the tar to percolate into the roadway. Given those three essentials, a good macadamized surface, dry weather during operations and evenly distributed sprinkling of tar, a road surface is produced which is impervious to water and is practically dustless.

A second sprinkling given a few months later will still further improve the roadway, and with a third sprinkling a surface is produced equal to the most expensive asphalted pavement to be found anywhere.

RAILWAY IMPROVEMENTS IN ROUMANIA.

A bill has been introduced in the Roumanian parliament to authorize the expenditure within the next five years of $80,000,000, for the completion of railway lines now under construction, the improvement of existing lines by double tracking, building of new stations, etc., and the construction of new lines of about 1,000 miles in length, and of a bridge over the Danube.

It is stated that motor cycles are coming into extensive use in the cities and suburban roads of Egypt, the topography of the country being generally favorbale for sport and practical cycle riding. The machines used are almost all of French, Swiss and English make.

METHODS OF DESIGNING THE FLAT SLAB SYSTEM.

By W. G. Ure, B.A.Sc.

In taking up the question of design of flat slab floors it has been found impossible to give any definite and generally accepted solution, for the simple reason that, of all the methods of treating the subject outlined in the following pages, no one can be singled out as an established standard. Different lines of investigation pursued by different men have given different results, and these results lead to widely varying designs when applied to the solution of a definite problem. It is not possible in an article of this length to go fully into these methods of design, and this chapter will therefore be devoted to an attempt to place before the reader the fundamental principles upon which some of the commoner of these methods are based, and to a comparison of the results attained thereby. It must be left largely to the individual reader to use his own judgment and experience in deciding which solution he would prefer to adopt.

In the flat slab system of floor construction we have the three fundamental stresses to provide for, viz., tension, compression, and shear. The tension and compression are due to moment action and it is with regard to their computation that most of the uncertainty exists. The determination of the shearing stresses is comparatively simple and will be considered first.

The shear is of two classes as before noted—punching shear and shear tending to produce diagonal tension. The safe stress for concrete to be used in computing the resistance to punching shear has been placed by the Joint Committee at 120 lbs. per sq. in. The safe stress to which concrete may be submitted in diagonal tension is the same as that which is safe for straight tension or from 40 to 50 lbs. per sq. in. The usual practice in the design of reinforced concrete is not to compute the diagonal tension at all, finding the punching shear only and using such a low permissible stress that the other will be automatically provided for. Let us then assume the safe shearing stress for concrete as 40 lbs. per sq. in. There is a well-known principle that at any point in a beam, the vertical shear, the horizontal shear, the diagonal tension, and the diagonal compression are all equal. Hence by limiting the allowable stress in vertical or punching shear to 40 lbs. per sq. in., we are also at the same time limiting the stress in diagonal tension to the same amount, and we may then not consider the latter in the rest of the design.

In any flat slab design there is a large amount of steel centering at the column and this, of course, may be utilized in the resistance of shear. This steel reinforcement may be stressed in shear up to 10,000 lbs. per sq. in. Then the total resistance to shear is the strength of the concrete at 40 lbs. per sq. in. plus the strength of the steel at 10,000 lbs. per sq. in. It has been shown by experience that practically the same result is obtained if the steel be neglected and the concrete figured at a stress of 80 lbs. per sq. in.

In actual practice it is probably just as easy to compare the shear from first principles. However, a formula may be derived as follows:—

Consider a section around the edge of the column cap, which in general would be the critical section.

Let A be the area of floor in sq. ft. sending load to the column.

a, the area of the column cap in sq. ft.

p, the perimeter of the column cap in inches.

jd, the distance in inches from the centre of compression to the centre of steel.

w, the combined dead and live load per sq. ft. of floor.

v, the intensity of shearing stress per sq. in.

Then the load tending to shear the floor at the edge of the capital is $w\ (A - a)$ lbs.

The area provided to resist the shear is $(p\ .\ jd)$ sq. ins.

Then v equals $\dfrac{w\ (A - a)}{p\ .\ jd}$ lbs. per sq. in.

The required depth of slab should be computed at the edge of the column cap, at the edge of the column shaft proper, and preferably at one or two points in between. Then, by plotting these depths the size and shape of the flare required at the top of the column is obtained. From the equation it will be seen that v may be decreased by an increase of either p or jd.

It frequently happens that the depth of slab is fixed from other considerations, hence in considering the section at the edge of the column cap jd is fixed, and v must be controlled by varying p. The tendency from æsthetic considerations is to fix the width of the cap by the size of the column beneath, and it may happen in an upper story where the columns are small that the width of cap be reduced too much. From a structural point of view the width of the column cap does not depend at all on the size of the column beneath, but only on the load to be carried on the floor above, and this load may be just as great on the top story as on the lower ones. The depth of the column cap will depend on both the size of the column and the floor load.

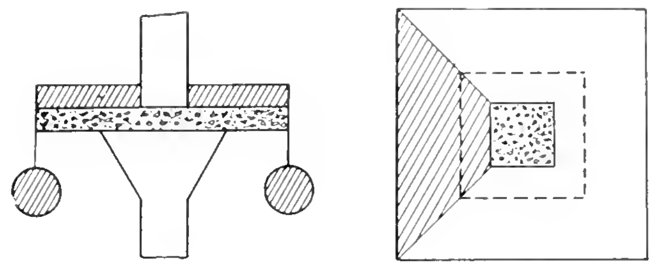


Fig. 1.

In all some eight methods of figuring the moments in the flat slab will be given brief consideration. The first two methods, viz., the "Cantilever Method" and "Turneaure and Maurer's Method," may be grouped together as being based on the principle that the portion of the slab over the column head out to the point of inflection acts as a cantilever, and the rest of the slab acts as a suspended span hanging from the edge of the cantilever.

The Cantilever Method is a simple application of the principles of statics, based on certain preliminary assumptions. The point of inflection is assumed at a distance out from the centre of the column equal to one-fifth of the span. The cantilever portion is then assumed to be a square whose side equals two-fifths of the span. Fig. 1 shows this part of the slab with a uniform load over its surface and a concentrated load equal to the weight of the suspended span hanging from its extremity. It is then a simple matter to compute the moment at any section. Moments should be found about the edge of the column shaft, the edge of the column cap, and preferably at one or two points between. The depths required can be then obtained, and the size of flare found in this way compared with that found by considering the shear.

The suspended span is analyzed by dividing it into strips, as in Fig. 2. Consider two such strips, one $A—B$ running diagonally across the panel, and the other $C—D$

along the side of the panel. Fig. 3 shows the bands of steel and the location of these strips. The figures on the shaded portions indicate the number of bands of steel crossing at that point. Assume that where one band only is present it takes all the load, where two are present each will take half the load, and so on, each band taking its proportionate share of the load. Fig. 3 also shows the way in which these strips will then be loaded, and the bending moment in each can be readily calculated. Having obtained the moments, the depth of slab and amount of reinforcing required is found in the usual manner.

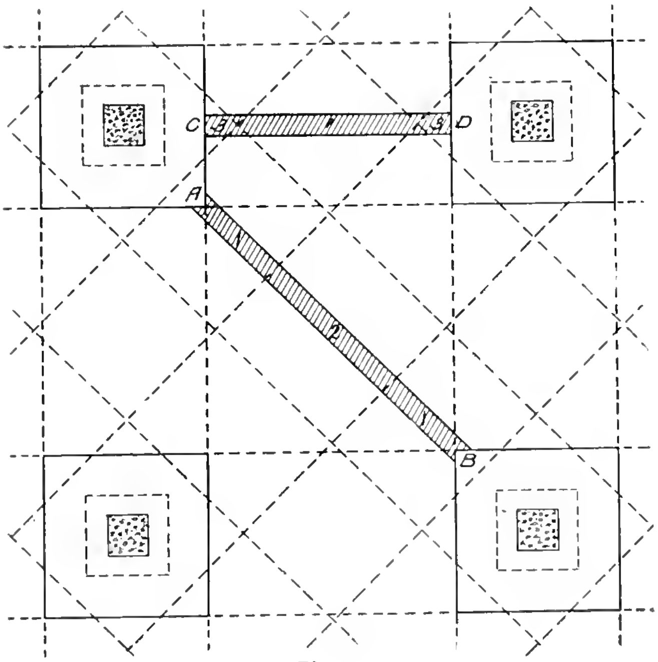


Fig. 2.

There are at least two serious objections to this method. In the first place it depends on the position and form of the line of inflection which is indefinite, and in the second place it takes no account of slab or arch action in the slab itself.

Turneaure and Maurer's Method is a modification of the above. It consists in considering the slab over the column head out to the point of inflection as a flat, circular plate uniformly loaded and supporting the rest of the slab as a concentrated load around its circumference. The radius of the circular plate is taken as the mean of the distances out to the point of inflection in a diagonal direction and in a direction along the side of the panel, the points of inflection being assumed at the fifth points. The determination of the moments is somewhat difficult mathematically, but they may be easily obtained by means of tables or graphs provided. The suspended portion of the slab is solved in a manner exactly similar to that used in the cantilever method. Graphs and tables for the solution of the flat slab by this method are given by Sanford E. Thompson in his paper entitled "The Practical Design of Reinforced Concrete Flat Slabs," published in *The Canadian Engineer* for March 28th and April 4th, 1912.

This method is open to the same objections as the previous one. It gives a thickness of slab approximately 50% in excess of that given by any other method, and this excess thickness, we can safely say, is unnecessary from our knowledge of the behavior of slabs under test loads.

Another Method of analysis is to divide the slab into a number of beam strips, as proposed by Mr. W. H. Ham in the proceedings of the National Association of Cement Users, 1911, page 195. The assumptions which he makes can be readily understood from Fig. 4. The load on the diagonally hatched portion is assumed to be carried by the diagonal beams, one-half being taken by each, and that on the vertically hatched portion by the cross-beams. The loading on diagonal and cross-beams would then be as indicated in the figure. The section required can then be obtained by the usual methods for solving reinforced concrete slabs, using the moment formula for beams fully restrained, partially restrained, or freely supported, as the case may be. The remaining portion of the slab over the column head is solved as a cantilever. The bars in the cross-beams are brought to the top of the slab over the columns. The bars in the diagonal bands run straight through on the bottom, and additional bars are provided at the top of the slab to take up the cantilever moment in the diagonal direction.

While this is, undoubtedly, a safe method of procedure it neglects the effect of arching action in the slab, and thus the result would tend to be unnecessarily heavy. On the other hand, it is simple to apply, uses only established engineering formulae, and the necessary allowance for end and corner panels is readily made.

Another Method is proposed by Louis F. Brayton in the proceedings of the National Association of Cement Users, 1910, page 269. He considers the structure as a slab reinforced in two directions and takes the moment at the centre as $-\frac{Wl}{12}$. Considering the load to be carried one-half each way we get a maximum moment at the centre of $\frac{Wl}{24}$ and double this over the columns. Brayton claims that where the length of the panel is more than one and one-half times the breadth it is conceivable that the slab might not become a warped surface under certain conditions of loading, but that the maximum deflection might be along a line perpendicular to the middle point of the long axis. In such a case the whole load should be assumed going in the direction of the long span. In order to make use of the assumption of two-

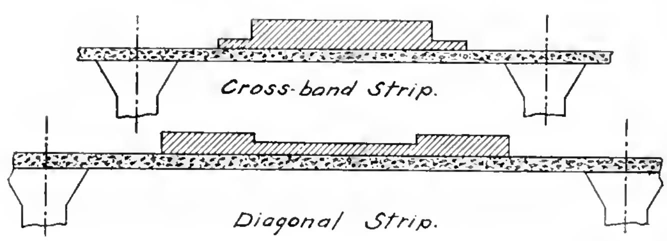


Fig. 3.

way reinforcement, Mr. Brayton assumes the strength of the diagonal bars replaced by its resolved parts parallel to the length and breadth of the panel. The use of such a low moment factor gives a heavy design, but his treatment of the long, narrow slab would seem reasonable.

In his book, C. A. P. Turner refers to Grashof's analysis and a treatise by Dr. Eddy entitled "Theory of the Flexure of a Thin Flat Plate or Ring Loaded Symmetrically About its Centre." However, his method of design appears to be purely empirical. From a series of experiments, such as were described in the writer's article in June 6th issue of this journal, he obtained the formula $\frac{Wl}{50}$ for bending moment. It would appear that his tests were made on isolated panels only, and if this be true he has built up his formula

on insufficient data. His designs are extremely light and seem somewhat daring when compared with designs made by other engineers. In some cases floors built by Mr. Turner have not stood up well under service.

Grashof's Analysis of the "Stresses in an Infinite Flat Plate supported on a Series of Points Dividing it into Rectangular Panels" may be used for the design of flat slabs. The proof is rather intricate but the results are comparatively simple and are given by Mr. Mensch as follows:

Bending moment at centre $\frac{Wl}{52.8}$

Maximum bending moment $\frac{Wl}{26.4}$

Maximum deflection $.0284 \frac{Wl^4}{Et^3}$ in which the value of

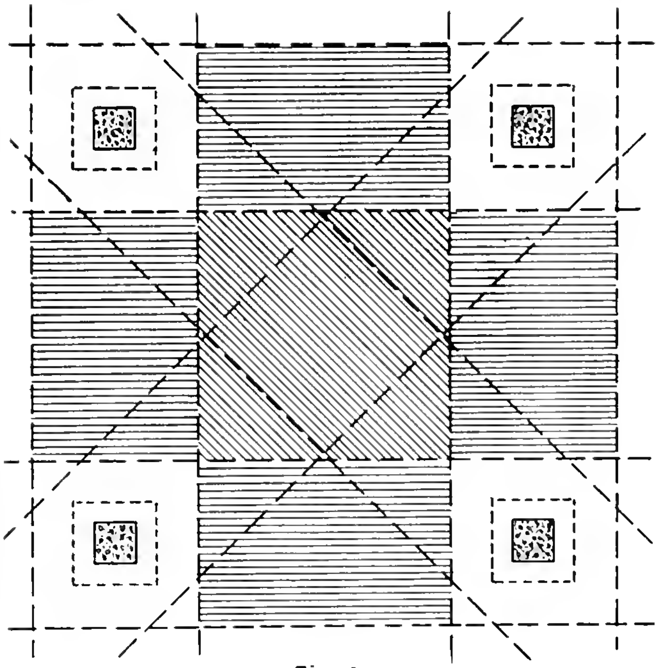


Fig. 4.

Poisson's ratio is taken as one-third. The objection to this method is that Grashof's Analysis is based on the assumption that he is dealing with a square plate of homogeneous material and uniform thickness, in fact the proof is indeterminate for other than a square plate. Actual flat slab floors are seldom exactly square, are not homogeneous throughout, and the flare of the columns, coupled with the fact that more layers of steel are present at some places than at others (changing the position of the centre of tension and thus the effective depth) make the assumption of uniform thickness unfair. Further, the slab can hardly be said to be supported at four points, as it is actually fixed over a considerable area at the corners. In spite of these discrepancies, however, the moment formulae given probably express pretty well the conditions actually existing.

L. J. Mensch describes a method based on the above. He claims that the formula $\frac{Wl}{48}$ for maximum bending moment at the centre of the span may be deduced from Grashof's writings. He then reasons that the same ratio of bending moment between the ideal condition of a continuous beam uniformly loaded, and such beams as designed and loaded in an every-day building, shall also hold good for the girderless floor. This ratio is $\frac{Wl}{24} : \frac{Wl}{10}$ or 1 : 2.4 Then, reducing $\frac{Wl}{48}$ in the same ratio he obtains $\frac{Wl}{20}$ as his working moment formula, and this, he claims, gives a factor of safety of four.

McMillan also obtains his formula from Grashof, but by a different line of reasoning. He quotes two of Grashof's formulae for maximum fibre stress in square plates uniformly loaded as follows:

Supported on two edges $f = \frac{3}{4}\,\frac{W L^2}{T^2}$, and fixed on four points, $f = \frac{W L^2}{4.27\, T^2}$. These values are in the ratio of 3.2 : 1. He then assumes that the ratio of the bending moment in a beam or slab simply supported and uniformly loaded and that in a flat slab will be the same. The formula for the former is $\frac{Wl}{8}$; therefore the corresponding formula for the flat slab is $\frac{1}{3.2} \cdot \frac{Wl}{8}$ or $\frac{Wl}{25.6}$. For convenience the value $\frac{Wl}{25}$ is taken and the slab figured out on this basis.

From this discussion it is evident that the Grashof formulae are unsatisfactory because, if for no other reason, they are capable of too many interpretations. The revised Cleveland building code gives the formula $\frac{Wl}{27}$, and the writer is inclined to believe that the correct value of the moment coefficient lies around 25 or 27. For purposes of comparison it will be interesting to tabulate some of the coefficients in use. Very few municipal building codes adequately cover this type of construction, and some of these work on the cantilever principle, notably Portland, Oregon, so that it is not possible to make an extensive table.

Authority.	Moment coefficient.	Authority.	Moment coefficient.
Grashof	26.5	Turner	50
Mensch	20	Brayton	12
McMillan	25	Cleveland building code	27

The following table is given by G. C. Stone and will serve as a comparison of the results to be obtained by these methods. The original table was the work of A. B. McMillan and covers six methods, to these Brayton added the result as it would be according to his method, for the sake of comparison Stone added the figures for a slab, beam, and girder design, and the figures for Ham's method were added by the author. The comparison is defective because the same stresses are not used throughout. The steel stress in Turner's method is 13,000 lbs. per sq. in., in all others it is 16,000 lbs. per sq. in. This is probably justifiable because the low stress used by Turner may be said to be an integral portion of his system of figuring. In the figures according to the Cantilever and Turneaure and Maurer's methods the concrete stress is 750 lbs., and so far as the author has been able to determine 650 lbs per sq. in. is used in all the other designs. The only apparent reason for using the high stress is that by so doing the slab thickness is kept down to a value which compares with that obtained by the other

methods. Unless the cantilever principle of analysis has some feature that would justify the use of a higher stress than otherwise, we cannot consider the comparison absolutely fair for all concerned. It is, however, the best obtainable.

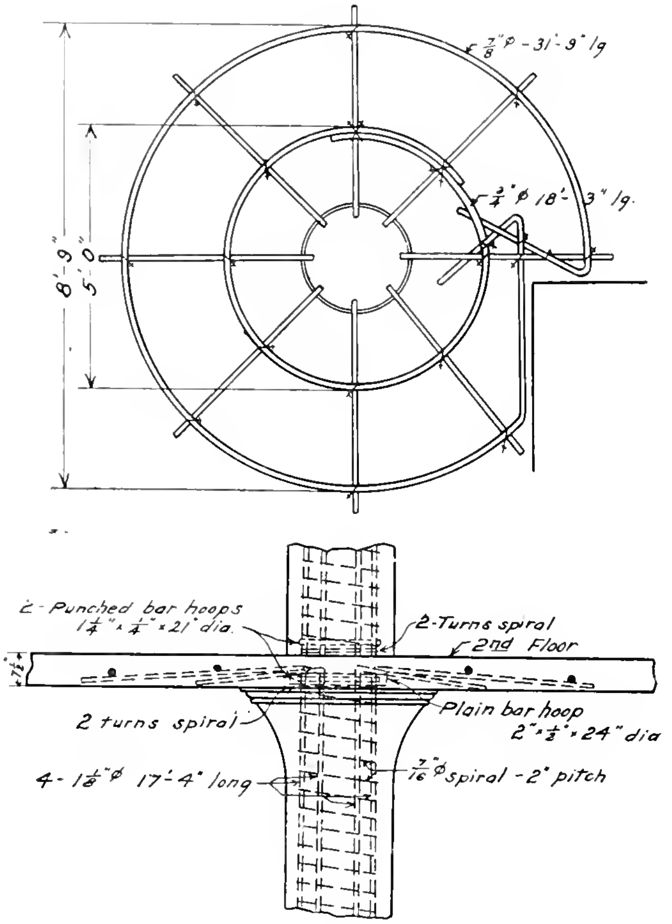


Fig. 5.

The following table gives the design of a panel of a floor according to the flat slab system as figured by various designers. The panel is assumed twenty feet square and is to carry a live load of 200 lbs. per sq. ft.

Authority	Slab thickness.	Steel in lbs.	Cost of steel
Cantilever	8"	2,189	\$87.56
Turneaure and Maurer	12"	1,931	77.24
Ham	8"	2,378	95.12
Brayton	8½"	1,900	76.00
Turner	8"	718	28.72
Grashof	8"	784	31.36
Mensch	8"	2,120	84.80
McMillan	8"	1,084	43.36
Average	8.6"	1,638	\$65.52
Slab, beam and girder	12"	2,300	92.00

The design of the radial steel cap on the column head which supports the bands of reinforcing is mostly a matter of economy and ease of erection. There are several patents on these caps, and one must either pay a royalty to the inventor or use a design materially different and probably inferior. In some of the designs it is certainly permissible to figure on their carrying a certain amount of stress; in others the practice would be indefensible. In general, it may be said that their function is primarily to hold the reinforcement in position, and any stress which they may carry is a secondary consideration only. Fig. 5 shows the details of a typical cap of this kind, it being Turner's design. It would appear to be very efficient although the wisdom of utilizing the main column reinforcement in this way might be questioned.

The reinforcing steel in usually plain medium steel bars of ½ in. or ⅝ in. diameter, used as they come from the mill and cut to length. They are commonly allowed to sag into position by their own weight, but it is much better if they are bent to the proper shape. This may be economically done by means of a right and left double-bar bender, which bends the bar to the exact shape at a very low cost.

The concrete is usually a 1:2:4 mix for broken stone or an equivalent one for gravel, no stone larger than ¾ in. being used. It should be mixed wet enough to flow readily around the reinforcement, it being generally recommended that it be of about the consistency of brick mortar. Where joints or bulkheads are necessary they should be made in a vertical plane and at or near the centre of the slab.

On December 13th, 1911, a new building code came into force in Cleveland, Ohio, embodying the latest knowledge on the subject of reinforced concrete building construction. It is particularly complete, and the design of floors by the flat slab system is given careful attention. There are many matters of importance which have not been dealt with in this thesis because not much information on them is available. These include the conditions in end and corner panels, the effect of narrowing the panel, the design of wall beams, and wall and corner columns. These questions are covered by the Cleveland building regulations, and in conclusion little better can be done than to quote some of the clauses of the code which refer particularly to the flat slab system of floor construction.

"Unit Stresses.

Medium steel in tension	16,000 lbs. per sq. in.
Concrete in direct compression	500 lbs. per sq. in.
Concrete, extreme fibre in compression	700 lbs. per sq. in.
Concrete in diagonal tension	40 lbs. per sq. in.

The compressive stress in the steel shall not exceed $\frac{c\,Es}{Ec}$ where c is the compressive stress in the concrete.

"Flat slab construction shall be figured with a bending moment in any quadrant over the column head of not less than $\frac{Wl^2}{27}$ in foot lbs, in which w is the total load per sq. ft., dead and live load; and l is the length in feet of the side of an equivalent square in rectangular panels, and the side of the square in square panels. This length shall be taken centre to centre of columns. The bands of reinforcing shall be made approximately $\frac{7}{16}\,l$ in width. In solving for the required area of steel over the column head, the distance from the compressive face to the plane of steel assumed shall be from the centre of gravity of all the steel to the under side of the slab. Any additional steel required over the column head shall extend beyond the centre of the column a distance not less than 0.3 l in all directions.

"The radial bars may be assumed as resisting tension, provided they are carried a distance horizontally not less than 0.1 l before bending downward; and further, that the allowed area of each radial bar figured to resist tension shall constitute not over one-half of the area of any single band of continuous reinforcement. The diameter of interior spirally

reinforced columns shall never be less than $\frac{l}{13}$ for floors nor $\frac{l}{14}$ for roofs, and the diameter of column head shall never be less than $\frac{l}{5}$; and this head, if constructed of concrete, shall be dropped below the under edge of the slab at least three inches at the outer edge.

"Rectangular panels shall never be less in thickness than $\frac{l}{45}$ the diagonal distance from centre to centre of columns for floors, and not less than $\frac{l}{50}$ for roofs.

"The minimum thickness of slabs shall be $6\frac{1}{2}$ in. for floors and 6 in. for roofs.

"The required percentage of steel in a single layer of bars shall not exceed 0.44% for medium steel or 0.30% for high carbon steel. In any flat slab type of construction provision shall be made to take care of circumferential stresses.

"In end or wall panels in which columns of reinforced concrete with heads are omitted, allowance shall be made for the increased moments. These moments shall be assumed to be 10% greater than the moments in the interior panels.

"If wall columns are used they shall be calculated to carry one-half the panel load plus any other loads, and if necessary the columns shall be designed for eccentric loadings. The wall beams shall be designed to carry one-third of the panel load plus any other loads. The minimum width of wall beams of reinforced concrete shall be 12 in., and never less than one-half the depth of the beam."

ELECTRIC STEERING-GEAR.

In a new method of controlling electric motors used for operating ordnance, steering-gear, swing bridges, etc., a rotatable resistance box is geared to the driven apparatus, so that when the contact arm is moved, and the apparatus is set in motion, the box follows the arm until the latter stands at the "off" position, when the motor comes to rest. The rheostat is arranged to act on the fields of both the dynamo and the motor, so as to reverse the direction of the latter without affecting the direction of the former.

The Robb Engineering Company has been completely reorganized with increased capital under the name International Engineering Works, Limited. The engine and boiler plants at Amherst, N.S., will continue to build the full line of horizontal and vertical Corliss engines, single-valve, high-speed, and English type of vertical compound engines, etc., so well known throughout Canada.

Tar as a covering for iron work must be used with great care, inasmuch as the crude material contains sulphuric acid and ammonia. This may cause serious pitting and rusting. Furthermore, it does not adhere well to bare metal and should never be applied except as a covering for other pigments The refined product offers the advantage of great resistance to foul atmospheres and corrosive gases. On account of its dark color the presence of rust cannot be easily detected.

FLOORS AND FLOOR SURFACE FOR FACTORIES.

H. N. Allott, C.E., in the course of an address to the Manchester Society of Engineers, says that for shop floors laid on concrete, where the work is of a heavy description, the best floor surface is one of wood blocks, 4 inches deep, which may be formed by sawing off 3-inch deals to lengths.

To prevent damp from rising through the concrete, the upper surface of the foundation should receive a coat of coal-tar pitch about ¼-inch thick, applied hot, and the blocks should be dipped in the hot coal-tar and bedded while the pitch is hot, any open joints being afterwards run in with pitch.

Where the work is of a lighter character, the most satisfactory wearing surface is grooved and tongued maple planking, nailed either to 4 by 3-inch battens laid in the concrete, or to planks laid transversely.

The battens should be creosoted, or dipped in "jodelite" or "sideroleum," or some similar wood preservative, and the planking laid in hot tar. It is very important that the whole surface of the floor should be thoroughly tarred before the wood blocks or planking is laid, and that any wood blocks or pegs used for levelling purposes should be removed.

Where the loads are very light and the foundation good, tar concrete may be substituted for the cement concrete, the upper surface being tarred as before.

The supported floors of a multi-story building, or of galleries, are usually constructed of concrete where a fire-resisting floor is required, or of timber in other cases. Where a concrete floor is used it may be constructed of reniforced concrete, or preferably of rolled-steel joists and concrete, as the more or less concentrated loads from machines and materials coming on the floor can be more easily arranged for.

In this case the floor can be constructed of small steel joists from 4 to 7 inches deep, according to the span and load, spaced about 2 feet apart, and finished with a flat ceiling. If the concrete is arched or recessed between the joists, hangers can be easily attached by hook bolts to carry countershafting. Another method, where the loads are considerable, is to use joists of heavier section, and to form an arched floor of concrete between these.

The upper surface of the floor can be finished with wood planking as previously described. If the floor is constructed of timber, wood joists bedded on the steel main girders can be used, with wood planking laid on top.

AUSTRALIAN RAILWAY GAUGE.

A conference of the chief engineers of the Commonwealth and state railway departments in Melbourne has urged the immediate adoption of a uniform 4 ft. 8½ in. gauge throughout Australia. The estimated cost of carrying this into effect is $185,000,000.

According to Prof. J. Goodman, in his paper read before the Institute of Civil Engineers, the safe load for a roller bearing, when the speed is not abnormal, may be calculated by the formula $P = Klnd^2 (ND + 2{,}000d)$, in which P is the safe load in lb.; l and d the length and diameter of rollers, in in.; n the number of rollers in the cage; N the r.p.m. of shaft; D the diameter of shaft or sleeve upon which the rollers run; and K a constant which has a value of from 1,200,000 to 2,000,000 when steel rollers are used, the workmanship is of the highest class, and when all surfaces are hardened and ground. For bearings with cost-iron casings and soft steel rollers and shafts, where the workmanship is of an ordinary grade, K may be taken at about 400,000.

CANADA'S ESTIMATED EXPENDITURE, 1913-14.

The following carefully compiled table will be of interest to readers of the *Canadian Engineer*. It shows the estimated expenditure of the Dominion for the fiscal year to end March 31st, 1914, together with the grants which were made for the year ending March 31st last. The table also includes a statement showing the increase or decrease for each service when the two fiscal years are compared.

Service	1912-13	To be Voted, 1913-14	Authorized by Statute	Total	Compared with Estimates 1912-13	
					Increase	Decrease
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
Public Debt, including Sinking Funds	13,380,614 31		13,144,913 01	13,144,913 01		235,701 30
Charges of Management	451,800 00	509,800 00		509,800 00	58,000 00	
Civil Government	5,535,765 84	5,637,745 52	267,066 66	5,904,812 18	369,046 34	
Administration of Justice	1,360,383 34	86,183 34	1,285,300 00	1,371,483 34	11,100 00	
Dominion Police	97,000 00	104,000 00		104,000 00	7,000 00	
Penitentiaries	645,700 00	650,500 00		650,500 00	4,800 00	
Legislation	1,686,032 83	861,614 00	801,500 00	1,663,114 00		22,918 83
Arts, Agriculture and Statistics	2,610,500 00	2,508,500 00		2,508,500 00		102,000 00
Quarantine	199,000 00	273,000 00		273,000 00	74,000 00	
Immigration	1,431,250 00	1,520,250 00		1,520,250 00	89,000 00	
Pensions	250,992 27	22,868 75	286,506 25	309,375 00	58,382 73	
Superannuation	400,000 00	400,000 00		400,000 00		
Militia and Defence	8,896,397 00	10,479,065 00	21,600 00	10,500,665 00	1,604,268 00	
Railways and Canals—Income	1,034,716 13	985,397 33	55,000 00	1,040,397 33	5,681 20	
Public Works—Income	22,290,251 40	22,927,635 00	15,000 00	22,942,635 00	652,383 60	
Mail Subsidies and Steamship Subventions	2,232,600 66	1,916,934 00	321,666 66	2,238,600 66	6,000 00	
Naval Service	3,140,500 00	2,570,000 00		2,570,000 00		570,500 00
Ocean and River Service	1,265,400 00	1,240,400 00		1,240,400 00		25,000 00
Lighthouse and Coast Service	2,742,300 00	2,569,300 00		2,569,300 00		173,000 00
Scientific Institutions	417,500 00	471,400 00		471,400 00	53,900 00	
Marine Hospitals and Sick and Distressed Seamen	73,000 00	68,000 00		68,000 00		5,000 00
Steamboat Inspection	57,000 00	60,000 00		60,000 00	3,000 00	
Fisheries	1,076,200 00	1,163,900 00	160,000 00	1,323,900 00	247,700 00	
Subsidies to Provinces	10,281,042 56		11,008,402 26	11,008,402 26	727,359 70	
Mines and Geological Survey	444,900 00	496,400 00		496,400 00	51,500 00	
Labour	85,300 00	90,300 00		90,300 00	5,000 00	
Indians	1,929,825 00	1,647,662 00	204,560 00	1,852,222 00		77,603 00
Royal Northwest Mounted Police	785,100 00	838,000 00		838,000 00	52,900 00	
Government of the Northwest Territories	8,800 00	8,000 00		8,000 00		800 00
Government of the Yukon Territory	303,000 00	303,000 00		303,000 00		
Dominion Lands and Parks	2,464,109 50	3,084,909 50		3,084,909 50	620,800 00	
Miscellaneous	1,046,170 00	728,885 00	196,500 00	925,385 00		120,785 00
Customs	3,070,000 00	3,830,000 00		3,830,000 00	760,000 00	
Excise	825,800 00	911,607 00		911,607 00	85,807 00	
Weights and Measures, Gas and E. Light Inspection	234,166 00	258,600 00		258,600 00	24,434 00	
Adulteration of Food, &c	32,000 00	32,000 00		32,000 00		
Railways and Canals—Collection of Revenue	11,859,015 00	14,904,830 00		14,904,830 00	3,045,815 00	
Public Works—Collection of Revenue	646,600 00	684,400 00		684,400 00	37,800 00	
Post Office	10,596,287 91	11,942,975 00		11,942,975 00	1,346,687 09	
Trade and Commerce	1,931,462 00	1,294,262 00		1,294,262 00		637,200 00
Total Consolidated Fund	117,818,481 75	98,082,323 44	27,768,014 84	125,850,338 28	8,031,856 53	
Railways and Canals—Capital	41,197,372 82	38,638,845 00		38,638,845 00		2,558,527 82
Public Works—Capital	8,332,512 91	12,202,000 00		12,202,000 00	3,869,487 09	
Public Works—Capital—Marine Department	1,878,000 00	2,461,000 00		2,461,000 00	583,000 00	
Total Capital	51,407,885 73	53,301,845 00		53,301,845 00	1,893,959 27	
Grand Total	169,226,367 48	151,384,168 44	27,768,014 84	179,152,183 28	9,925,815 80	
Redemption of Debt			9,720,043 34	9,720,043 34		

A new pulp mill is being constructed for the Abitibi Pulp and Paper Company in the vicinity of Lake Abitibi.

It is stated that the management of the Intercolonial Railway is to pass from that of a board of managers into the hands of a single commissioner, who is Mr. F. P. Gutelius, who was formerly superintendent of the Canadian Pacific Railway, and for the past year has been engaged in an investigation of the construction of the Transcontinental Railway.

In 1907 Canada imported 533 traction engines, valued at $588,234; in 1908, 698, valued at $6,043,723.

Manganese steel dredge buckets are to be used to overcome the difficulties experienced in excavating the Pacific entrance channel to the Panama Canal. The experiment is being tried, as the carbon steel buckets which are now in use are not sufficiently strong to endure the hard digging. The new buckets have a capacity of 35 cubic feet each and weigh 5,400 pounds.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.76** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.
H. IRWIN, B.A.Sc., EDITOR. A. E. JENNINGS, ADVERTISING MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404**, **7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square. T. R. Clougher, Business and Editorial Representative. Telephone 527 Central

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS:

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS

When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JUNE 19, 1913. No. 25

CONTENTS OF THIS ISSUE.

MONTREAL FILTRATION PLANT.

In Montreal some conflicting opinions among engineers are forming the basis of much controversy concerning the $5,000,000 filtration works under construction at Verdun, to supplant the city's present water supply system.

It will be remembered that, in 1910, Montreal called in the services of Messrs. Hering & Fuller, consulting engineers, of New York, to report on the prospect of a safer and better supply of water for the city. In July of that year the engineers submitted their report, recommending the use of St. Lawrence River water, subjected to double filtration. The recommendation was adopted, and they were retained to co-operate with Mr. Janin, chief engineer, and Mr. Lesage, engineering superintendent of waterworks, in the preparation of plans and specifications and in the supervision of building operations.

Of the four contracts into which the work of construction was divided, those covering the building of the prefilters, filtered water reservoir and final filters, were awarded to Mr. F. H. McGuigan, contractor, of Toronto. Details regarding the general type of construction were published in the January 18th, 1912, issue of *The Canadian Engineer*.

Owing to ill-health Mr. McGuigan found it necessary to discontinue operations last fall, and the work, which had progressed favorably through several months, was taken over by Mr. Norman M. McLeod, contractor, of Montreal.

Recently Mr. McLeod served the city council of Montreal with a protest, alleging that the site chosen by Messrs. Hering and Fuller, in conjunction with Mr. Janin and Mr. Lesage, was most unsuitable for such a structure, the soil being insufficiently firm, owing to the presence of quicksand. He also claimed that there were serious defects in the design of the filters, and that severe cracking and similar symptoms of failure and collapse were in evidence. He predicted that the structure would be of little usefulness when completed. Opinions of prominent engineers, familiar with the conditions, corroborated, in whole or part, Mr. McLeod's statements.

Acting upon a joint petition from the Board of Trade, the Fire Underwriters' Association and the Canadian Manufacturers' Association, a board of independent engineers was appointed by the city, to inquire into the situation, carefully inspect the site, and ascertain to what degree the contractor's statements were founded upon fact. Messrs. P. W. St. George, J. A. Jamieson and Frank A. Barbour formed the personnel of the board. At the same time the city officials were strongly of the opinion that insufficient protection from frost last winter had been the cause of the pronounced subsidence and cracking of the foundation and walls, the uncompleted filters having remained open and empty during the months of frost.

It is understood that the board of examining engineers has made a thorough study of the ground upon which the structure is being built, and that the earth has been found by them to be quite suitable for the purpose.

The probable result of the report is predicted to be that the contractor will be required to complete the filtration plant according to specifications, and that the responsibility of damage by frost may not be charged to other than himself.

Because filtration plant installation is, as yet, in a more or less experimental stage in America, from the difference of opinion among Montreal engineers concerning suitability of site, it is to be expected that information of value to other cities and towns with similar problems ahead of them, will be derived.

OCEAN FREIGHTS.

The question of advances in ocean freight rates, both import and export, is of considerable importance to engineering and contracting supply houses, and many will be interested to know that it has again been discussed by the Montreal board of trade. It was decided to call the attention of the government to the matter, with a view of learning whether Great Britain and the other maritime nations could be induced to take joint action for the control of rates. As a preliminary step the transportation bureau committee of the board recommended that the Dominion government should be asked to appoint a commission of inquiry with a view to arriving at all the facts in connection with the advances in rates that have taken place within the last few years.

The question of ocean rates arises periodically. It is alleged, and generally believed, that they are regulated by combination. The question was investigated to some extent by Mr. Richard Grigg, chief Canadian Trade Commissioner, when he held the position of British Trade Commissioner in Canada. In a report to the Imperial Government in 1907 he said: "It must be a matter of opinion as to whether rates of carriage are higher than the service warrants, and if they are, it is perhaps easier to state the fact than to formulate a remedy. Assuming them to be so, it would appear that part of the preference designed to encourage the import of British manufacture goes into the pockets of steamship owners, and thereby to some extent defeats the intention of the preference by checking the import of British goods. Of course, no such conditions operates in regard to American goods, which are not subject to ocean carriage.

"It seems only reasonable to suppose that the officers of a company or conference whose employment and advancement must be justified by results, will strive to use every means placed at their disposal for the advancement and profit of the service to which they are attached unless restrained by policy imposed upon them by higher authority, and if this be so, the question is considerably narrowed. The condition with regard to the deferred rebate by means of primage (which is incapable of concealment) appears to establish the desire of the conference to discourage competition, and so to maintain rates; and the remaining problem is the extent to which the line of policy indicated is pursued. The answer is important to British trade, and it appears desirable that it should be sought and the whole facts made known upon competent authority."

That was apparently an appeal to the Imperial Government to investigate the matter. The subject of the control of ocean freight rates has frequently been brought to their attention, but little progress has been made with a view to an unbiased investigation. Meantime shippers pass sheafs of resolutions and the shipping companies are looking after their own interests.

EDITORIAL COMMENT.

The Canadian Electrical Association meets in Toronto June 25th, 26th and 27th. An excellent programme has been prepared and special rates are at the disposal of those desiring to attend.

* * * *

In his report for the year 1913, just issued, the Commissioner of Works for the city of Toronto recommends the construction of 20,400 feet of cement concrete sidewalks, 2,050 feet of asphalt pavements, 400 feet of brick pavements, and 10,000 feet of concrete pavements. His recommendation also includes 4,000 feet of curbing.

* * * *

An interesting feature of Col. Ruttan's report to the Winnipeg City Council, concerning the city's water supply project, is his proposal to bring the supply into the city through a tunnel to be driven through the rock below the bed of the Red River, the tunnel to be of sufficient size to carry three or four forty-eight-inch pipes, with provision for future extensions.

* * * *

A Convention of the American Waterworks Association will be held in Minneapolis during the week of June 23rd, and a very complete programme has come to hand concerning the papers to be read, the reports to be presented and provision for entertainment. It is not unlikely that Canadian cities will be well represented. At any rate the nature of the proceedings will be of great value to Canadian waterworks engineers. The Society for the Promotion of Engineering Education hold their convention in Minneapolis at the same time, and at one session the two organizations will hold a joint meeting.

* * * *

The Government has awarded the contract for the construction of lock-gates on sections three and four of the Trent Valley Canal. The southern portion of the canal is thus nearing completion. It is also reported at Ottawa that tenders will shortly be called for the beginning of work on the northern section, from Lake Simcoe to Georgian Bay via the Severn River. This will complete the waterway from Georgian Bay to Lake Ontario. To date, the canal has cost in the neighborhood of $11,000,000, and will require approximately $5,000,000 before it is finished.

LETTERS TO THE EDITOR.

Sir,—Referring to the article under the heading "Disadvantages of Chemically Pure Water as a Beverage" in your issue of May 15, the writer came across an instance of its truth a few years ago in Gibraltar, where the naval authorities, for a while, supplied all the dockyard staff in government quarters with distilled water which had not been aërated.

The use of this water brought on constipation, and for a time caused a good deal of unnecessary discomfort to the unfortunates to whom it was supplied.

Distilled water was largely sold to the citizens by the sanitary commissioners during the dry summer months, but this was properly aërated and no trouble ever seemed to result from drinking it.

Yours faithfully,

ALFRED S. L. BARNES.

Toronto, May 22, 1913.

THE PLOTTING OF RAILWAY CURVES

A METHOD OF PLOTTING TO A DISTORTED SCALE—SUITABLE FOR RELINING EXISTING CURVES—DOUBLE TRACK WORK—STATION LOCATION ON CURVE, ETC.

By J. L. BUSFIELD, B.Sc., A.C.G.I.

In a paper read before the British Institute of Civil Engineers in 1909 by Mr. W. H. Shortt, A.M.I.C.E., on "Railway Transition Curves," a method of plotting railway curves was described, together with the mathematical proofs of the accuracy of this method, and also details of some of the uses of this method in practical railway work were given.

Mr. Shortt, in his paper described the interdependence of scales in distorted diagrams in the following way: "If a given circular arc be plotted with the radius struck to a scale of $a \times b$ feet per inch, and the length of the arc marked off to a scale of a ft. per in., then a scale of a/b ft. per in. must be used to scale off the true distance of any given point from the arc, **provided such distance is small compared with the radius of the arc.**"

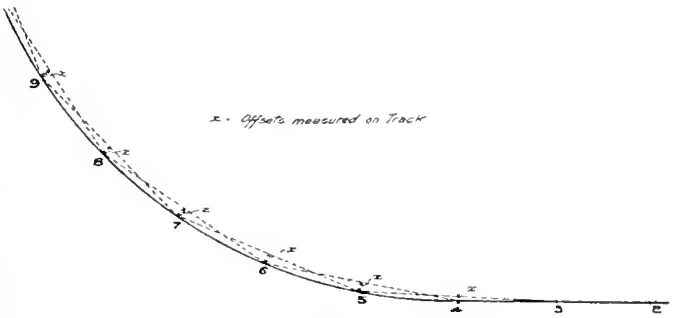


Fig. 1.

Now, for general use scales in the proportions of 100 to 10 to 1 should be used for the radius, arcs and offsets respectively, i.e., if the radius of the arc is made 400 ft. per in., and a distance measured along the arc to a scale of 40 ft. per in., then the small measurements at right angles to the arc can be made to a scale of 4 ft. per in.

This method of plotting has been used with success in Great Britain, and the writer has used it for different purposes and found it satisfactory for practical use.

The use to which it was originally put in Great Britain was for the re-alignment of existing railway curves, with the insertion of transition curves where they did not formerly exist. A preliminary survey was first made of the curve to be remodelled, by marking off on one predetermined rail, consecutive stations, one chain length apart, commencing at a point on the tangent at least 2 or 3 chains before the commencement of the curve. After this was done the curvature was obtained by means of taking offsets from chords 2 chains long. This was very rapidly and easily performed by stretching a cord between alternative stations and taking the offset at the intervening station. In addition to this all controlling features, such as the edges of the fills, or cuts, bridges, tracks, platforms, etc., were located by means of offsets from the rail used as a base line.

The survey thus obtained of the track and adjacent structure was then plotted to a distorted scale, preferably using either the 100-ft., 10-ft. and 1-ft. per in., or the 200-ft, 20-ft. and 2-ft. per in. scales. This was done by laying off the tangent and then plotting the chords by the offsets obtained in the field, and then joining up the ends of the chords with a continuous curve, as shown in Fig. 1. The full line representing the alignment of the rail used as a base line, and the dotted lines showing the chords and offsets x by means of which the curve was located and plotted.

In Fig. 2 the same curve is shown by the dotted line, the construction lines being erased, and the controlling structures have been plotted, also to the distorted scale, and from these the maximum shift permissible on either side is obtained. In the figure the arrow heads represent the limits between which the rail may be moved. The next thing to be done is to fit on an improved alignment. This is shown as finally completed by the full line.

The best position for this improved alignment is obtained by trial. A curve is drawn to the same distorted scale of about the same radius, and a transition curve is inserted between the points marked A and B in Fig. 3. The curve DBC is drawn with a radius approximately that of the curve on the ground with the beginning of curve at point D. The correct distances DF and FA for the transition curve can be computed from various formulae, then B the end of the tran-

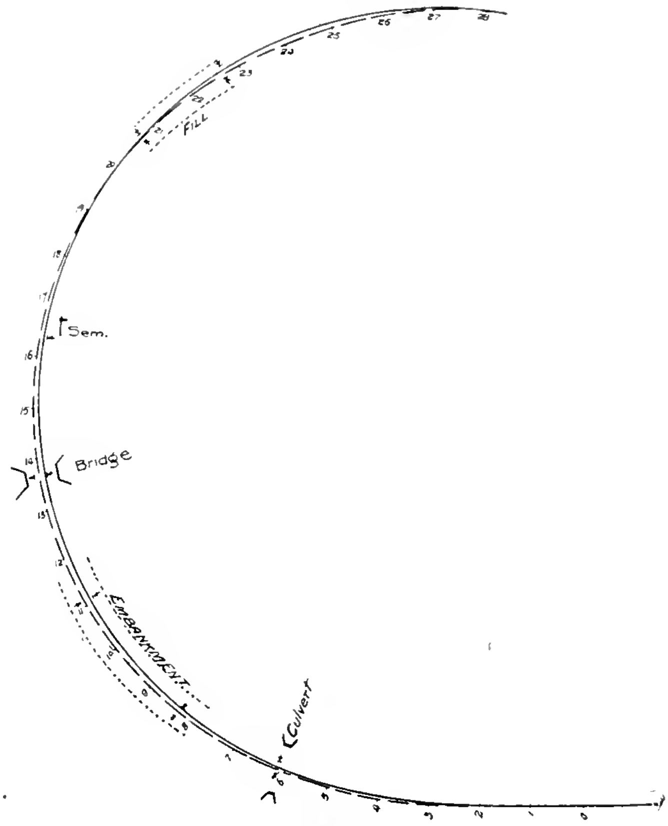


Fig. 2.

sition curve is located by making DB = FA, and also G, bisects DF, so three points on the transition curve are obtained. The intermediate curve can then be readily plotted

as a cubic parabola, by dividing AF and DB into an equal number of parts, and taking cubic proportions of the distance GF. If this curve is plotted on tracing paper, it can then be superimposed upon the original alignment curve and by trying different curves a suitable one can be obtained to give the best alignment with the minimum shift of track and keeping within the defined limits, as shown in Fig. 2. The distance the track has to be moved at each station can now be measured off on the diagram to the correct scale, and if these measurements are then staked out in the field and the track lined over a good alignment will be obtained. This is only one of the simpler cases in which this method of

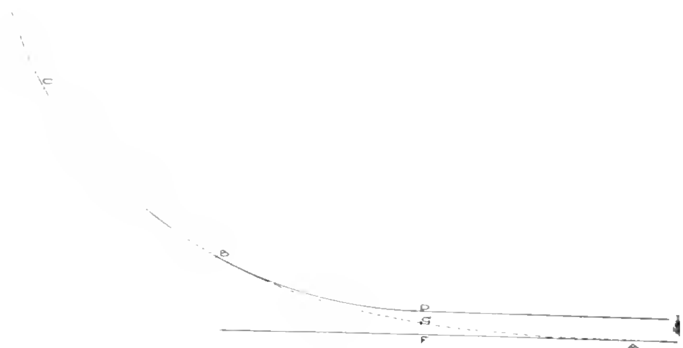


Fig. 3.

plotting was used, and other more complicated ones are described by Mr. Shortt in his paper.

The writer has used this method of plotting curves for two different purposes and found it very satisfactory in both cases. The first case was for relining existing railway curves, with the insertion of a spiral curve without disturbing the centre portion of the curve more than absolutely necessary to make it truly circular.

The first step was to draw to a scale of 100 ft., 10 ft. and 1 ft. to the inch, distorted diagrams of different curves varying by ½ degrees up to the maximum curvature likely to be met with. An example being shown in Fig. 4, where ADC represents, say, a 3-degree curve. It is now required to insert a spiral without altering the location of the tangent of the centre of the curve. To do this it is necessary to calculate the distance S required for a spiral to a curve slightly sharper than the original one plotted, and also to calculate the length of spiral required for this curve. The line EG should then be drawn parallel to the tangent AD, and a curve EFC drawn tangent to EG at E, and tangent to curve ADC at C, care being taken that EC is longer than half the length of spiral, and then a cubic parabola can be drawn in, as shown by the dotted line ABF.

Starting from the BC of the original curve 25 ft. or 50 ft. distant are marked off to the 10-ft. scale, along the arc DC and also along the tangent DA, and at each of these points the offsets x are measured between the circular curve and the spiral curve ABFC. As the scale for these offsets is 1 ft. to the inch they can be measured within a ¼ of an inch, which is just close enough for track work. The offsets can then be tabulated for the different degrees of curvature, ready for use in the field.

In staking out a curve with the new alignment, the BC is located in the usual way and the transit is sighted along the tangent and stakes put in every 25 or 50 ft. (according to choice) from the BC, each being offset a certain amount according to the tables, until the point of spiral is reached where the stake is set on the centre line. The transit is then reversed and angles deflected in the regular way round the curve, the stakes again being offset the correct amount until the end of the spiral is reached. In this way the curve ABFC is staked out on the ground.

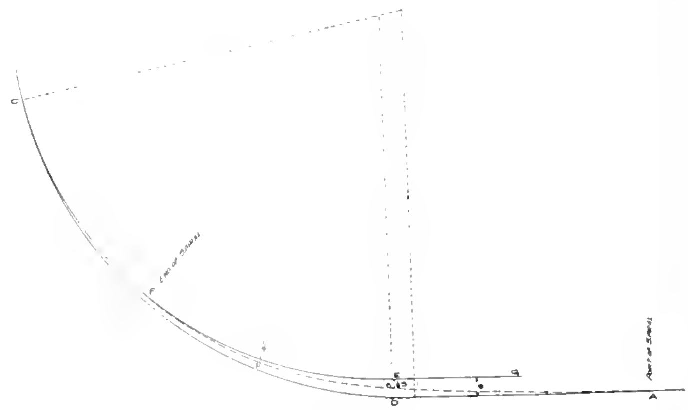


Fig. 4.

This method, though not theoretically correct, has the great advantage that it takes no more time in the field than it requires to stake a simple curve, and it also gives a satisfactory spiral without changing the central portion of the curve. The writer has used this method frequently on main line work and found it perfectly satisfactory. In one instance a 5½° curve at the foot of a 1% grade was spiralled in this manner, and the trains passing onto this curve did so in a smooth and easy manner. The portion of the curve CF that is sharpened above the main curve can be made so short and of such a small amount sharper that it is practically negligable.

It frequently happens in railway double track work that it is required to take advantage of a curve in the tracks to increase the distance between the centres of the tracks; for example, if a bridge is required at the centre of a long curve it might be desirable to use a girder between the two tracks which would have to be separated to perhaps 15 ft. centres instead of 13 ft. Another instance where this occurs is at stations located on a curve, it may be desirable to put a platform or standpipes between the two tracks requiring 18 ft. to 20 ft. centres at the centre and only the standard 13 ft. centres at the ends of the curve. The distorted curve diagram can readily and easily be used to assist in the laying out of work of this nature.

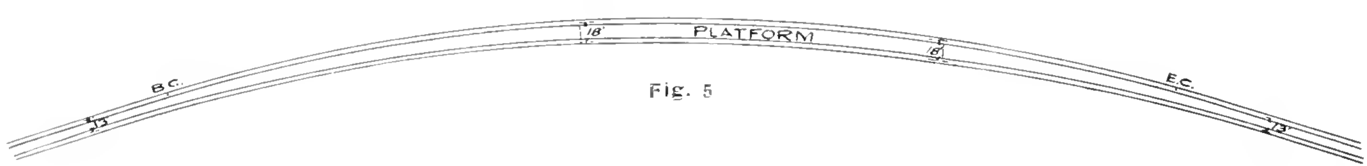


Fig. 5

Taking the case where a 13-ft. platform is necessary between the two main lines, as shown in Fig. 5, at the ends of the curve on the tangents the tracks are 13 ft. centres and opposite the platform the tracks are 18 ft. centres and parallel, so that between the ends of the platforms and the tangents the two tracks have to converge 5 feet.

In laying out this work one track would be staked out as a uniform curve in the usual way, and one method of locating the second track would be to run intersections at either end of the curve and then stake these out independently of the first curve. This method takes considerable time and requires several men to do it. The other method is to plot a 3-scale curve which will facilitate the work, requiring the time of one man for about half an hour to do the necessary plotting.

The method of procedure is to draw the tangent and regular curve as staked out on the ground, and shown in Fig. 6 by xyz. If a 100-ft. scale is used for the radius, the distance from the BC to the beginning of the platform GF is scaled off 10 ft. to the inch. Now we have the condition that the two curves must be parallel at the platform and 18 ft apart, and also parallel at the tangents 13 ft. apart, or the same result is obtained by assuming 2 curves to run from the one

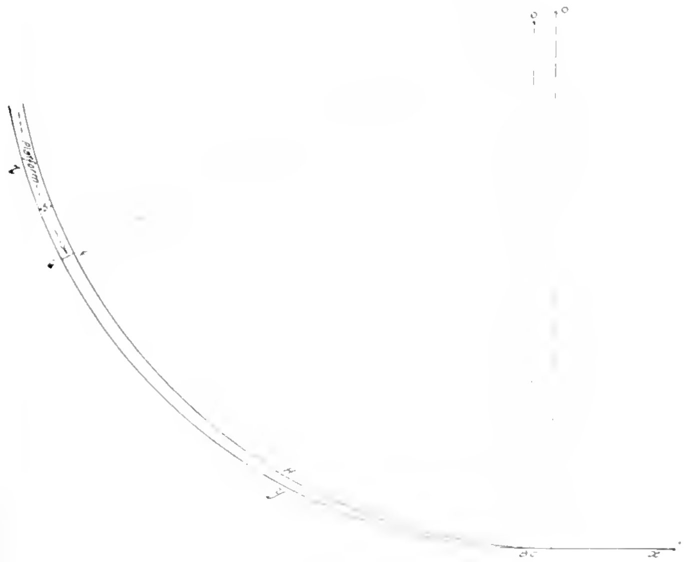


Fig. 6.

tangent and spread out 5 ft. apart at the platform, or at the point G in Fig. 6. Now, making FG = 5 ft. at 1 ft. = 1 in., it is now necessary to draw in a curve with its centre on the line GO, or GO produced which will also be tangential to the tangent X. This curve is shown FHX.

Equal distances can now be marked off along the tangent and curve XYZ, corresponding to the positions of the stakes on the ground. The offsets between these points and the new curve GHX can now be scaled off and made us into tabular form. If necessary, the process should be repeated for the other end of the curve and the tables giving the station of the stakes (or numbers for identification) and the corresponding track centres opposite each stake should be given to the track foreman who will then be able to give the second track its correct alignment.

This method has been used by the writer with success, and it has proved to save time in the field and work more satisfactorily than staking out individual curves.

The International Geological Congress will be tendered a reception by the civic authorities on Monday, August 12th. Delegates will be received in the council chamber, city hall, by His Worship the Mayor. It is understood that the Federal and Provincial Governments are providing for similar receptions to the delegates on their extended trip across Canada. It is expected that the convention will be attended by over eight hundred members.

LAYOUT, DESIGN, AND EQUIPMENT OF INDUSTRIAL PLANTS.

By A. Home-Morton.

The importance of an adequate amount of time being spent upon the design proper in the creation of industrial works and establishment of industries is receiving increasing attention as a special branch of Applied Engineering involving the consideration of every problem which might arise from the conception to the realization of the enterprise. In recent issues of *The Canadian Engineer* the design of a structural steel plant was carefully dealt with, every phase bearing upon construction and subsequent operation receiving its due amount of attention. In a paper read recently before the Liverpool Engineering Society Mr. A. Home-Morton dealt with the design of industrial works in general, dividing his subject into six sections, viz.: General and financial considerations; labor and labor conditions; general arrangements; generation and transmission of energy; design and consideration of the works structure; and reconstruction.

Efficiency and Economy.—The stress of competition in modern industry demanded efficiency with economy in every department. Industrial engineers were in consequence frequently called upon to supplement estimates of the capital cost of a projected undertaking with estimates of the working costs, maintenance, and even of profits. These demands in proprietors' interests were, under certain conditions, legitimate and desirable, and the engineer-designer must be able to satisfy the proprietor with such estimates, accurate to within a moderate percentage. Careless estimating ought to be inconsistent with professional honor.

Due consideration of and for the worker was now being accepted as a sound business policy. There was a tendency toward improved labor conditions and the reduction of physical drudgery by the introduction of aids to labor.

A certain school of economics contended that the increase of mechanical appliances tended to lower the standard of excellence and skill in handicraft, and, consequently, the intelligence of the craftsman, but it was equally true that the greater perfection of the results, increased rate of production, and usually greater reward obtained with mechanically aided labor tended to improve labor conditions, and to uplift, rather than to degrade, the worker.

It must be clear that in order to secure not only quantity but quality of output, the interest and skill of the worker and the perfection of equipment must be maintained unimpaired.

A general arrangement must be considered with reference to the character and quantity of the output, and the limitations and disabilities of the site. Actual plants designed to produce the same commodity on sites of varying form were found on examination to have similar essential areas, even although they might differ somewhat in arrangement. This suggested a relationship between floor area and output, which, theoretically, ought to hold, and on investigation would be found to apply even in plants which had grown from humble beginnings. Such a ratio of floor area to output would vary with the magnitude of the output, although it would probably hold for average conditions over a considerable range in magnitude.

Processes and Routing of Work.—The first essential to a general arrangement design was the "process diagram," and the second the "routine diagram." The process diagram was simply the enumeration in tabular form, or the graphical presentment, of the several shop processes. When to a graphical diagram of a process of manufacture was added a complete schedule of the areas required to house the machines necessary to produce a given output, then a complete "process diagram" was the result.

From the process diagram and the basis areas already mentioned, the engineer-designer with an intimate knowledge of the whole process of manufacture, and of the machines necessary to accomplish the process in each particular section, might proceed to prepare the routine diagram, which represented graphically the flow of work in process. In preparing this, the plant should be so arranged that the material dealt with and manufactured should flow through them in an orderly manner, in one direction, so far as might be, and without waste of time, energy, or material.

The routine diagram was probably the most difficult part of works design. It involved the sequential arrangement of the machines within each department, and thereafter the laying out of the departments relative to each other To carry this out successfully required great skill and care, and probably much tactful discussion with the proprietors, managers, and foremen of the proposed works.

From the data available, however, suitable approximate linear dimensions and heights for buildings might be fixed, and thereafter the manipulation of these blocks might proceed until the most satisfactory relative positions of departments were secured. The routine diagram was complete when the several departments were arranged on paper, and the flow of work in progress through the departments was as perfect as possible. The first design was rarely final, for the final plan was usually a combination of the leading features of several draft plans.

It could not be too well remembered that the buildings should accommodate the plant, that the process of manufacture should not require to accommodate itself to the buildings, and that the transmission of power was an integral part of the scheme, and must be considered from that standpoint.

The subject of power generation and transmission in industrial works had been frequently and exhaustively treated in recent years. The mass of information was, however, so technical, so varying, and so conflicting in its conclusions as to be, in a great measure, beyond the grasp of most power users. The first conclusion, and that to which it was difficult to reconcile the partisan mind, was that each system of power generation and transmission had its particular advantages and superior economy, and that maximum economy in works driving in a particular case might be obtained by a combination of two or more systems.

Transmission of Power.—The difficulty was usually not so much the selection of the system as the determination of the extent to which it should be utilized. Where the plant was compact and conveniently arranged within a radius of, say, 100 or 150 feet, from the central power plant, mechanical transmission was economical, while with an increased radius, gas or electrical transmission had advantages. In small works and factories the most careful thought ought to be given to the works design in order to ensure a compact arrangement and efficient mechanical transmission. The chief advantages of the electrical transmission system were its adaptability and the ease with which it could be extended.

Under the industrial conditions which held to-day and were becoming increasingly stringent, no manufacturer who was building or reconstructing works or mills could afford to neglect the technical skill which was at his disposal quite irrespective of cost. It might be argued that a works manager or proprietor knew most about his business and its needs.

But it could be urged quite legitimately that the proprietor's business might be the mining of coal, or the manufacture of iron or steel, ships, chemicals, or textiles. In that sphere he was at his best, but in the design of buildings, the selection of power plant, or even the economical arrangement and correlation of them he was at a disadvantage. Whether this disadvantage was serious or might only involve a permanent tax upon his business, when accepted, must be left to his own judgment.

Those industries which held a world-wide reputation in America, in Germany, and in England had in every instance been either originally designed or reconstructed by experts.

HIGH-TENSION CONTINUOUS-CURRENT TRACTION.

In a paper in which he considered the high-tension continuous-current system of traction M. L. Gratzmuller discussed the generation of such current, the overhead conductor, the motors and their accessory apparatus, the control, and the safety of the system and the protection of the staff. He also described a few recent installations.

In concluding, he remarked that the title high-tension continuous-current traction was not very happy, as it implied an entirely new type of apparatus, whereas in fact it only marked steady development. From 500 volts it passed to 600 volts, and then to 750 volts. The trains from Villefranche to Bourg-Madame used current at 850 volts. Certain sections of the Budapest system were now run at 1,000 volts, and to-day the system was applied to locomotives at 2,400 volts, and even 3,000 volts was talked of. This progress had been justified by improvement in the commutation of the motors, due principally to the use of auxiliary poles and to recent methods of insulation by means of mica and impregnation. The cost of transmitting the energy must not be overlooked in view of the weight of copper required for the lines and the cost of sub-stations. In order to make a comparison with other methods of traction—viz., single-phase and three-phase—the length of the line and the intensity of the traffic should be taken as independent variables. Heavy traffic was a favorable factor for high-tension continuous-current traction.

The advantages of continuous-current were principally the large starting torque, the quality of the commutation (which was shown by the small wear of the commutator and the brushes), and the light coaches. On the other hand, there were the drawbacks of the use of an exposed high-tension rotating part—particularly dangerous in damp localities—the use of a commutator, and the control of the large currents necessary when a large amount of power was required.

CANADA'S SHARE OF IMMIGRATION.

A total of 52,580 British emigrants, left the United Kingdom for countries outside of Europe during April, 1913. As many as 37,948 proceeded to other parts of the Empire, 29,984 going to Canada and 5,533 to Australia. Of the remaining 14,632, all but 603 went to the United States.

In the first four months of the year 133,350 natives of the British Isles emigrated, over three-fourths of whom have been retained within the Empire. They were distributed as follows:—

Canada	66,911
Australia	23,432
New Zealand	4,881
British South Africa	3,366
Other colonies and possessions	3,418
Total British Empire	102,008
United States	25,522
Other foreign countries	2,820
Grand total	133,350

PERMISSIBLE DILUTION OF SEWAGE.

By George W. Fuller, M. Am. Soc. C.E.

At a meeting of the hydraulic, sanitary and municipal sections of the Western Society of Engineers the more salient features of the sewage dilution problem formed the subject of a most instructive paper. Reference is made at the outset to the extensive literature concerning the Chicago drainage canal, the various streams of Massachusetts which the State Board of Health has subjected to report, and the general scheme of sewage disposal for the metropolitan district tributary to the New York harbor, as well as to the more recent investigations carried on by numerous large cities throughout America. The subject matter of the address directly pertaining to the permissible limits of sewage dilution is contained in the following:—

The liquid portion of all sewage or water-carried waste must go to the water courses sooner or later. The only exception occurs where the sewage is evaporated. Mention is made of this feature in order to accentuate the thought that the water courses of this country must receive the water-borne wastes in some form or another. The question becomes, therefore, one of the degree to which liquid wastes are improved as to their quality before they are finally disposed of by dilution in some water course.

It is perfectly obvious that as civilization advances, and the population of the country increases, there can be no longer any streams of original pristine purity. That condition absolutely disappears, and such disappearance is one of the penalties of civilization. On the other hand, there are a great many streams in this country—some large ones, as well as numerous small ones—which are over-polluted with water-borne wastes. This is due to an overstepping of the proper limits of permissible dilution which we are to discuss here.

Definitions.—Sewage is defined as the spent water supply of a community together with those trade wastes and street washings which in some instances are removed in underground channels called sewers.

Sewage Disposal.—The art of sewage disposal means the economical elimination or prevention of nuisances with respect to these water-borne wastes.

Types of Nuisances.—Nuisances due to sewage naturally are grouped into two classes: One refers to conditions that are offensive to the senses of sight and smell. The other refers to the hygienic aspect of the matter and to the transmission of disease germs contained in the sewage to neighboring communities through the water of the stream into which the sewage is discharged. These disease germs refer, of course, to those of the water-borne group, such as typhoid fever, Asiatic cholera, and others of intestinal origin.

The hygienic aspect of sewage disposal is naturally related in many instances to questions of water supply. It is also intimately associated with shellfish problems along the seaboard. Public health officials also have to deal with this aspect of the question with respect to public bath houses and possibilities of transmission of certain diseases by flies from deposits along the shore of some highly polluted water courses.

Hygienic Aspects of Sewage Disposal.—The sterilization of sewage discharged into tidal waters in the general vicinity of shellfish layings has within the last few years proved an economical and, in the hands of careful operators, an efficient means of dealing with one of the important phases of the hygienic side of this question. While there are only a few sewage sterilization plants now in operation, there have been a dozen or more recommended for adoption and it seems unnecessary here to state more on this question in view of the thorough discussion which it has received from Professor Phelps in Water Supply and Irrigation Paper No. 229 of the U.S. Geological Survey. Hypochlorite of lime, or some similar sterilizing agent, has a great future before it in the treatment of sewage at places where shellfish are found within certain distances.

Sewage disposal in its relation to public water supplies is, of course, the most important hygienic feature, and it is a question upon which viewpoints vary widely. Some believe that all sewage should be purified so thoroughly that it will practically resemble spring water and so that there will be no need of water purification.

In the opinion of the writer all questions of water supply and sewage disposal should be viewed in the light of all local conditions, having in view that the treatment adopted should give the best returns for the money spent when due regard is given to the benefit derived in the interests of the public health.

The Royal Commission on Sewage Disposal of Great Britain has considered this question at length and its conclusion was as follows:

"We are satisfied that rivers generally, those traversing agricultural as well as those draining manufacturing or urban areas, are necessarily exposed to other pollutions besides sewage, and it appears to us, therefore, that any authority taking water from such rivers for the purpose of water supply must be held to be aware of the risks to which the water is exposed, and that it should be regarded as part of the duty of that authority, systematically and thoroughly, to purify the water before distributing it to their customers."

"Apart from the question of drinking waters, we find no evidence to show that the mere presence of organisms of a noxious character in a river constitutes a danger to public health or destroys the amenities of the river. Generally speaking, therefore, we do not consider that in the present state of knowledge, we should be justified in recommending that it should be the duty of a local authority to treat its sewage so that it should be bacteriologically pure."

The conclusion of the commission is a sound one and as a general proposition water purification rather than sewage purification affords a better safeguard of the public health in the present state of the art. It is also to be noted that water purification is not only more reliable, but it is also cheaper under most conditions.

In this connection it is to be borne in mind that untreated surface water supplies as a rule do not afford a thoroughly safe drinking water. The reason of this is that there are too many opportunities for pollution from the soil wash and indirect sewerage of small villages and hamlets, and the infection of the water from the casual huntsman, fisherman, or those who for pleasure or business traverse the watershed. There are, of course, exceptions to this rule, but they are growing fewer and fewer. This is well shown in Europe where, since the great cholera epidemic of Hamburg some years ago, it is an unwritten but practically effective law that all surface water supplies shall be filtered.

Many large cities in this country are provided with combined sewers, the entire flow of which at times of storms can scarcely be purified completely. It is true that hypochlorite of lime has proved to be of much help in securing an improved quality of drinking water at many places, but the fact remains that as a general proposition the surface water supplies in this country should be filtered in order to make them thoroughly first-class in point of hygienic character.

While it is believed that the purification of public water supplies in this country is a subject that must stand on its own feet first and foremost, it is undoubtedly true that there

are some exceptions to this rule and that sewage purification sometimes should be provided to aid the neighboring water supply. The medical man feels that everything that can be done to destroy disease germs should be done, and is inclined to say purify all sewage and also purify all water. This brings up the question of much practical significance of how a certain expenditure of money can be best applied in the interests of the public health.

The water purification should come first so far as the hygienic side of the matter is concerned, and sewage purification or perhaps sewage treatment by sterilization should come into play in order to make sure that water filters are not overloaded if there is likelihood of inferior quality of filtered water being furnished the consumers.

Double filtration of water supplies and the judicious use of sterilizing arrangements and the advantageous employment of coagulating processes can all be brought to the aid of the water purification plant. Even with all of these precautions as to the water supply, there are times when purification of the sewage of a neighboring community or of the community whose water supply is under consideration, should be carefully provided for. We shall say no more on this question of the hygienic aspects of sewage disposal, as it is hoped that the viewpoint has been made plain that the dilution method of sewage disposal is not barred from this line under ordinary circumstances. The limitations in the dilution method are really to be found in relation to the nuisance question as noted by sense and smell, and this is the question that we shall now proceed to discuss at length.

Nuisances as Related to Sewage Dilution.—Sewage dilution is an important, rational, and proper method of disposal of sewage if it is properly applied and is not abused. Disregarding the question of disease germs which we have already considered, the dilution method of disposal is a proper one when by dispersion in water the impurities of the sewage are consumed by bacteria and larger forms of plant and animal life, or otherwise disposed of so that no nuisance results.

The dilution method is by far the most prevalent one now in use in this country. As our knowledge becomes more precise as to its advantages and disadvantages, the conclusion becomes more clear that the method has not been applied in a satisfactory way in a large number of instances. On the other hand, there seems to be no good reason why advantage should not be taken of this method within reasonable limits. Between the so-called complete purification of the sewage and the dilution method there are intermediate procedures which allow advantage in point of economy to be taken of the dilution methods, and at the same time the nuisances to sight and smell, which have been so common at various places, may be effectively prevented.

Nuisances attending the sewage dilution method may be due to, (1) floating solids; (2) settling solids; (3) non-settling putrescible organic matters.

These three constituents, or groups of constituents, in sewage explain most of the difficulties that are encountered to-day with the sewage dilution method. We can all recall instances where orange peel and other household wastes float in bodies of water around sewer outlets. We are also accustomed to deposits of "sewage mud" or sludge near the outlets, and the likelihood of their decomposing and producing foul odors particularly at times of low stream flow. There is also the condition where there is inadequate dilution of the sewage as it enters the stream, and where the entire body of water turns black owing to anaerobic decomposition or so called septic action.

Clean Rivers.—There is undoubtedly a well-defined movement on foot to free American rivers of small and moderate size of solid organic matter and filth coming from the flow of sewers. This movement, in my opinion, is a proper one and, when combined with adequate purification of water drawn from rivers receiving such sewage, the whole question of sewage disposal by dilution assumes a more reasonable and favorable aspect than hitherto. Furthermore, it does not involve communities in the expense called for by sewage filtration. It modifies, however, the limits that are permissible as to sewage dilution and calls for a recasting of the engineer's views and calculations upon the question. We shall outline briefly some of the features involved in the permissible limits of sewage dilution in connection with "clean rivers."

Screens.—In America there has not been as much progress as in Europe in the use of screens or other arrangements by which floating matters objectionable to the sight are removed from sewage as it enters the stream. In Germany so-called fine screens with an opening of 0.4 in. or less have had many warm advocates. The fine screens have not the standing to-day that they had a few years ago, in the opinion of many engineers, owing to the success attending the sedimentation devices as a cheaper and simpler means of keeping back floating matters and at the same time of removing the coarse heavy solids that subside. In America fine screens have been regarded with questionable favor, owing to the cost of their maintenance. We shall not discuss the relative merits of different devices, but will confine ourselves to the statement that without question floating matters should be removed from sewage before the latter is disposed of by dilution in an adequate body of water.

Sedimentation Tanks.—An examination of the Massachusetts State Board of Health reports, and other American data on pollution of streams, quickly shows that the stranding of solids in the vicinity of sewer outlets has in the past proved one of the drawbacks to the satisfactory use of the dilution method. This is particularly true at times of low river stages when banks of "sewage mud" or sewage sludge are exposed to "putrefaction" with attendant bad odors. Some 60% of the total suspended solids in the ordinary sewage are responsive to subsidence, and unless the sewage is discharged into a river with uniformly high velocities, these solids are bound to strand or settle. The removal of these "settling solids" is an important feature in the establishment of "clean rivers" in this country and, if we eliminate a few of the larger streams, it is my opinion that sedimentation of sewage is going to come into general use as a preliminary step in the modern arrangements for sewage dilution.

In earlier days difficulties in disposing of the sewage sludge or solid matters deposited in tanks were the cause of the slow adoption of this important improvement. It is true that chemical precipitation and sludge presses provided a solution of the problem, but at an expense that proved discouraging to many communities, and such that in Europe the cities near the seacoast were led to "barging" the sludge to sea. It is believed that septicization, particularly as embodied in tanks of the two-story type, will allow this matter in the future to be handled far more satisfactorily than in the past.

Unimportance of Organic Matter in Settled Sewage.—If a sewage has been clarified to such an extent that there will be no deposits in the stream bed at or near the sewer outlet, and if the disease germs are killed, there then remains to be considered the sanitary significance of organic matter coming from the settled sewage, and diluted with large volumes

of river water. In most cases where the sewage is diluted so that there is formed no offensive odors due to decomposition, and where the sewage has undergone sterilization, it does not seem likely to us that it is necessary in the interests of the public health to go to the expense in most cases of removing the dead organic matter of the settled sewage.

It is intimated by some that the germ theory of disease and the specific infection of water through disease germs does not necessarily tell the whole story as to the hygienic disadvantages of sewage-polluted waterways. On the other hand, the extensive investigations of the United States National Board of Health, as stated in their report for 1882, page 201, indicate that with sewage-polluted waters, it would be necessary to drink half a gallon at once of the waters under test in order to get as much nitrogen and carbon as is contained in a single medicinal dose of strychnine, which is stated to be one of the most energetic of recognized poisons.

A similar view as to the harmlessness of organic matter *per se* was stated by the late Dr. T. M. Drown in the Special Report of the Massachusetts State Board of Health, 1890, Part I., page 537.

A similar view has also been given by Dr. A. C. Houston, now chief water examiner of the Metropolitan Water Board of London, in the Second Report of the Royal Commission on Sewage Disposal, page 27.

"Organic matter *per se* in water is seemingly harmless; it is the bacteria likely to be associated with the organic matter that constitute the element of danger. Only bacterioscopic analysis can hope to reveal the kinds of bacteria in an effluent which are of a sort liable to be related to disease. Chemistry is quite powerless in this respect, and, indeed, all chemical standards of potability are apparently based on an assumed relationship, which may or may not exist, between the amount of organic matter and the number and kinds of the associated bacteria. Typhoid fever stools, whether sterilized and innocuous, or unsterilized and highly dangerous, would yield to chemical testing practically the same results as regards the nature and amount of organic matter present."

Furthermore, where there is adequate dilution of settled and sterilized sewage in a river used for a water supply, it is not difficult, as already stated, to effect a substantial removal of organic matters in works well adapted for water purification and involving coagulation, aeration, and sterilization by powerful oxidizing agents.

Degree of Dilution.—On the assumption that floating and settling solid matters are removed from the sewage and that disease germs are killed, where necessary, by sterilizing chemicals, we can now come to the discussion of what the permissible limits are for the dilution of sewage. We can answer it by saying first that the limits should be such that there should be present at all times and in all places sufficient dissolved oxygen to prevent anaerobic or so-called putrefactive decomposition becoming established, and furthermore that there should be a reasonable margin of dissolved oxygen to take care of fish life unless it should prove in some instances that the question of fish life is not of sufficient significance to justify consideration.

On the degree of dilution the first scientific data in this country were obtained in the early days of the consideration of the Chicago drainage canal, and it is from the technical staff of the Chicago Sanitary District that engineers have received their latest information bearing upon this important subject. A few years ago, and in fact until quite recently, all data as to the degree of dilution of sewage referred to crude sewage with its floating and settling solids. The Chicago drainage canal was established on the legal limit of 3⅓ cu. ft. of water per second to dilute the sewage of each 1,000 persons connected with the sewers. That limit was probably too low for the crude sewage of a city which has such a large proportion of manufacturing wastes in its sewage flow as is the case in Chicago. For a city without manufacturing wastes it is probably a fair limit, although some data obtained from Massachusetts suggest that it might be wiser to provide a somewhat more liberal volume of water for dilution.

Generally speaking, a dilution of 4 cu. ft. per second per 1,000 population is as close a general figure for crude sewage as can now be obtained, although undoubtedly there are various local factors which influence the dilution and may establish a range as wide as from 3 to 7 cu. ft.

As to the degree of dilution necessary for settled sewage, present evidence indicates that at least 2.5 cu. ft. per second per 1,000 population should be provided for residential communities and where the diluting water is well supplied with atmospheric oxygen. For manufacturing cities, where the diluting water is moderately depleted in oxygen during the summer months, this dilution may perhaps have to be doubled, that is, increased to 5 cu. ft. per second per 1,000 population.

There is no precise rule now available, and the above ranges establish as closely as can now be done the permissible limits in the dilution which properly should be applied to settled sewage in preference to raw sewage with floating and settling solids in it.

Dispersion,—Mixing.—One of the great drawbacks to the dilution method of sewage disposal as applied in earlier years was then the tendency to conduct the sewage only to the margin of the stream and perhaps only to the high-water shore line. This explains the nuisances that prevail in many American cities where the stream flow throughout the entire cross-section of the river is sufficient to provide reasonable results by the dilution method. Enough has been said to indicate that if dilution is to be advantageously used, it should be done under conditions where the sewage is so mixed with the stream flow that the degree of dilution above mentioned will be secured at all points. Naturally, streams with comparatively high velocities allow better results to be obtained than those in which the velocity is reduced or checked entirely at times by mill ponds or other obstructions.

Residual Oxygen.—This is a question upon which there are many divergent views. Until it is put on a more satisfactory basis than at present, it is hardly feasible to state the degree of permissible dilution more closely than given above. Colonel Black and Professor Phelps have advocated that a residual margin of 70% of dissolved oxygen should be provided for the waters of New York Bay. A more common opinion places this margin at 50%. Messrs. Wisner and Pearse (of the Sanitary District of Chicago) have put this margin at 2.5 c.c. of dissolved axygen per litre, which is equal to about 20% of saturation of oxygen during winter months, and 30% for the summer temperatures. These gentlemen, however, have reference to fish life. My own experience is that if stranded solids have been kept out of the stream there will be no occasion for difficulty as to anaerobic or putrefactive decomposition, provided there is some dissolved oxygen present in the stream at all times and at all places. One of the earliest and most important points established at the Lawrence Experiment Station was that a little oxygen, say, 1% to 3% of that necessary for saturation, would allow oxidation and nitrification to take place as satisfactorily or nearly so, as if the water were saturated with oxygen. I know of no reason for departing from the teachings of those early experiments at Lawrence, and I believe

that estimates of 50 or 70% for the required residual of dissolved oxygen can be explained only by extraordinary allowances made for the consumption of oxygen by existing sewage sludge, or by more than liberal allowances of oxygen for major fish life In fact, whatever margin is needed above a slight positive quantity at all times and places in the stream is, in my opinon, solely accountable for by the oxygen necessary for fish.

Fish Requirements.—Data are somewhat meagre as to the amount of dissolved atmospheric oxygen which is required in the streams to protect major fish life. The quantity no doubt varies with different species of fish and perhaps other local conditions. In the Lower Elbe near Hamburg it is stated that the margin of dissolved oxygen during the ordinary summer periods falls as low as 20%, and the figure in the Lower Thames is understood to be about 30%. At Hamburg there has been no serious complication as to fish life other than during the summer of 1911, when it is understood that for three or four weeks fish actually migrated from the vicinity of the city. This does not mean that there was any nuisance as to putrefactive odors. In fact, it is stated that none existed. It shows also another point and that is that since the fish returned after a period of three or four weeks, it will be quite debatable whether once or twice in a generation it is necessary to prevent the migration of fish, if by such prevention there will be involved expenditures of vast sums of money for the more complete purification of the sewage.

I was told in Berlin a year ago that an amount of residual dissolved oxygen equal to 1 c.c. per litre was considered sufficient under ordinary circumstances in the immediate vicinity of a sewer outlet, although 1.5 c.c. were preferable.

Fungus Growth.—Professor Thumm, of Berlin, has stated to me that in waters containing a great abundance of oxygen it is possible that offensive odors might result through the growth of certain fungi, namely, Leptomitus, Sphaerotilus and Cladothrix. The staff of the Royal Prussian Testing Station have observed that these growths are said to be characteristic of streams receiving a lot of industrial wastes, such as come from wood pulp mills. The growths seem to be favored by the presence of much putrescible organic matter, ample dissolved oxygen, and a high velocity of stream flow. These comments are not in harmony with my recollections of the life history of these organisms, unless it be that their growth is fostered in certain deposits which are dislodged under certain conditions. The question is an interesting one, and it is the only suggestion that I have heard of which limits the permissible dilution of sewage in other than by the dissolved oxygen, in cases where disease germs are destroyed or may be properly ignored. This is a question which needs further study, and it may be entitled to more consideration than we now realize in America.

Comprehensive Designs.—While a firm believer in the dilution method of sewage disposal within permissible limits, as roughly outlined above, I am aware that many American towns and cities are likely to grow to proportions where the dilution method will require more and more complete treatment of the sewage in order to be satisfactory. It is the part of wisdom to prepare designs for sewage disposal works so that if filtration is not needed at the outset it can be adopted as conveniently as practicable in later years and without embodying too great a sacrifice in works now undertaken. This means, among other things, that intercepting sewers, sites for screening plants, and sedimentation tanks could well be arranged with the idea that some day filtration also must be provided. If this were done it would probably save considerable money that otherwise might be lost.

Relaxations.—In England the principal topic of conversation among engineers was found to be the forthcoming report of the Royal Commission on Sewage Disposal and the disposition in that report to provide for "relaxations." By this is meant that there would be installed, piecemeal, works which would provide ultimately for purification to the degree set out by standards recommended by the commission a few years ago. It is proposed now to take full reasonable advantage of dilution, but to arrange the works so that further and more complete treatment may be secured when and as required in the future.

Separate Sewers.—So far as household wastes are concerned, in all new systems and in many cases of extensions to existing sewer systems, it will be helpful to adopt the "separate system" to a greater extent than has been the vogue hitherto. The prevention of a mixture of the sanitary wastes of the household with the storm water from the streets will aid materially in minimizing the expense and in increasing the success attending sewage purification, sewage treatment, and the utilization of the dilution method within safe practicable lines.

Finally, then, it is permissible to dispose of sewage by dilution provided that complications can be prevented so far as disease germs are concerned, and this should be best done in connection with water filtration, and further provided that offensive conditions to sight and smell do not result.

In some large streams, as in the lower Mississippi near New Orleans, sewage which is passed through coarse screens may with care be disposed of in a satisfactory way. In large lakes, tidal estuaries, moderate and small streams, it is important, if not necessary, for the success of maintaining "clean rivers" or "clean bodies of water" to free the sewage from floating and settling solids.

Permissible dilution of sewage without treatment in water courses with fairly high velocities ranges apparently from about 3.5 to 7 cu. ft. per second per 1,000 population, depending upon the manufacturing wastes in the sewage and the dissolved oxygen content of the diluting water. For well settled sewage, these limits become about 2.5 to 5 cu. ft. per second per 1,000 population according to present information.

INTERNATIONAL ENGINEERING CONGRESS, 1915.

In connection with the Panama-Pacific International Exposition, which will be held in San Francisco in 1915, there will be an International Engineering Congress in which engineers throughout the world will be invited to participate. This congress will be conducted under the auspices of the following engineering societies: American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers.

A scale-testing car is being built by the United States Bureau of Standards for testing scales in yards, grain elevators, and other places where interstate traffic is handled. It will not itself be used as a load, but will carry movable weights, which will be used for testing. It is proposed to have the car carry a number of standard weights of 10,000 pounds each, and a large number of 50-pound weights. A truck, capable of carrying 50 tons, will be carried on the car to be used for moving the standard weights, in testing scales. The car will be equipped with a crane for lifting the truck and the heavy weights.

CALGARY'S PUBLIC UTILITIES.

Preparatory to striking the rate, based on the estimated expenditure for 1913, Calgary's city commissioners prepared a report on all the public utilities under their control. It showed:—

"During 1912 there were 47 miles of water mains laid, 324 hydrants set, and 3,116 new connections made to the mains. The expenditure on the aforesaid works charged to capital account was the sum of $558,846.52. The estimated revenue was $258,550.10, and the actual income amounted to $244,423.37.

"All bills chargeable to the waterworks system, up to December 31st, 1912, have been settled.

"The asphalt paving plant has been operated by the city since the month of July, 1912. Paving was constructed at an average cost of $2.10 per square yard; price quoted includes an allowance for debenture interests, sinking fund and plant depreciation.

"The capacity of this plant in 1912 was, approximately, 1,000 square yards per day, and the new unit now nearing completion will much more than double the capacity of the plant.

"The revenue derived from this utility was $87,558.02; the expenditure $103,247.38, $24,954.71 of the latter amount representing stock on hand, leaving a surplus of $9,265.53.

"The street railway has expanded beyond expectations. Starting operations in 1909 with two cars, half a mile of track and 16 employees, in December, 1912, the system had increased to 54 cars in operation, 60 miles of track, 246 regular men employed.

"During the past year it carried 14,627,370 passengers, earning a gross revenue of $603,975.38, with a total expenditure of $502,254.81.

"Its capitalization account stands at $1,615,000, of which has been expended $1,537,490, leaving a balance of $77,509.08 which is available for construction purposes.

"The electric light and power plant department, in the seventh year of municipal operation, continues to show gratifying financial results and satisfactory service.

"The normal peak load, namely, 7,000 horse-power, 5,000 horse-power of which is purchased from the Calgary Power Company, generating this energy by means of water-power obtained at Kananaskis Falls; the remaining 2,000 horse-power is produced by means of a battery of 16 boilers, six of which use as fuel, natural gas, and 10 coal, representing a total of 5,000 horse-power. There are 11 generators, whose prime movers consist of steam and electrical energy. The remainder of the city's power plant, representing 3,500 horse-power, is under stand-by to take over full capacity at short notice.

"The gross revenue received from the sale of electric light and power was $489,264.72, and the expenditure was $471,473.81, showing a net surplus of $17,790.91. The gross capital account amounts to $1,507,000, of which $1,454,017.40 has been expended, leaving a balance of $52,982.60. This makes a total gross plant account of $1,454,017.40."

The mill rate has not yet been officially announced, but it is expected that even though it has to provide for the unpaid bills of last year on sundry accounts, it will not exceed 16 mills.

Forest trees around the waterworks reservoir of Hornell, N.Y., will be planted by the Board of Public Works of that city in co-operation with the College of Forestry, of Syracuse University. It is stated that about 30,000 trees will be planted.

IRON AND STEEL PRODUCTION.

From the statistics which have just been published by the American Iron and Steel Institute relating to the production in the United States and in Canada of pig-iron and of iron and steel structural shapes, wire rods, and cut and wire nails, the increase in demand for these commodities in 1912, as compared with that of preceding years, can be fairly estimated. Taking the total of all grades of pig-iron, the increase of output by the United States between 1912 and 1911 was rather more than six million tons; and it is noteworthy that in making the 29,726,937 gross tons which constituted the output for 1912 the fuel consumed included 35,721,127 tons of coke, about 47,022 tons of bituminous coal, 73,794 tons of anthracite coal, and 35,436,017 bushels of charcoal, with over 15,000,000 tons of limestone and dolomite. In Canada there was also a substantial increase in output of pig-iron, thus maintaining the improvement which has been recorded year by year since 1903, with the single exception of 1908. The consumption of iron and steel structural shapes in the United States, which declined from the year 1909 to 1912, showed an increase in 1912. A feature of the figures representing output from the United States of these shapes, which include beams, tees, angles, and channels, and iron and steel for use in the manufacture of bedsteads, agricultural implements, fences, safes, plates, and girders, is that about 10 per cent. is exported, and that of these exports Canada in 1912 absorbed 169,952 tons, as compared with 103,054 tons in 1911. In 1912, the United States reached the maximum production of wire rods, and it is to be observed that in regard to the total 64,078 tons exported, Canada was again the best customer, taking 63,063 tons, as compared with 22,583 tons in the previous year.

REGINA IS WATCHING POWER EXPERIMENTS.

Regina's civic officials are desirous of solving the cheap power problem, and are following closely the experiments being made by Professor Darling for the provincial government. The board of trade recently had Professor Darling deliver an address when he very ably outlined his views. As the lignite coal fields from which it is proposed to develop power are about 150 miles from Regina, he proposes that the coal be carbonized, then shipped to Regina, and used as fuel for the generating of power. To generate the power at the mines and transmit it to the city would be an expensive proposition, he claims, unless numerous towns along the line, required power which is not the case at the present time. The cost of transmission such a distance would be very considerable. Mr. Darling has erected an experimental station at the coal fields, and the Regina board of trade intends to keep closely in touch with the results obtained, as the city is ever anxious to secure lower power rates for manufacturers, etc.

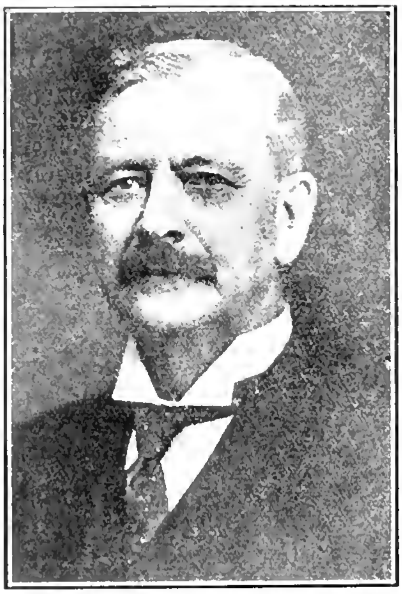
Mr. A. S. Porter, a well-known Regina citizen, who owns considerable coal lands, is organizing a $1,000,000 company for the purpose of developing power from the coal deposits on his land. He has set aside 15,500 acres of land to be mined for this purpose. A line of the Canadian Pacific Railway runs right through the property owned by Mr. Porter, and this he considers would make it an easy matter of getting the by-products such as briquettes, etc., to the cities and towns where they could be marketed.

Concrete work in the Panama Canal locks is nearly completed, the aggregate amount in place at the close of work on May 31, being 4,459,356 cubic yards.

ENGLISH INDUSTRIAL PLANT FOR MONTREAL.

The big industrial corporations of Great Britain and the United States are realizing the significance of the rapidly-growing markets of Canada. The United States Steel Corporation is establishing a large branch plant in Ontario and the Sir W. G. Armstrong Whitworth Co., Ltd., of England, will take a similar step, although their establishment will be in Quebec province. The company have acquired a site on the south shore of the St. Lawrence River, within Montreal harbor, and a plant will be erected there at an estimated cost of $1,000,000. This will be extended as often as needs justify. The Canadian branch of this famous company will be used solely for commercial or civil or mechanical engineering, and not for naval or military work. At no time will the company make guns, boats, or anything of that nature here. This is, at any rate, in keeping with the spirit of the celebration of one hundred years of peace in North America.

They will manufacture twist drills, punches, milling cutters, cranes, drop forgings, tool steel, etc.



M. J. BUTLER,

Largely through Mr. Butler's efforts and those of Sir Percy Girouard, the Armstrong Whitworth Company, of England, will establish a million dollar plant at Montreal.

The decision of this large English corporation to erect a branch plant in Canada is a great event in Canada's industrial history. It indicates the confidence of keen and observant business men and capitalists in Canada's future and that confidence is welcome and gratifying to Canadians.

British capital will finance the entire enterprise and no issue will be made in Canada. The share and debenture capital of the company is as follows:

	Authorized.	Issued.
Ordinary Shares of £1 each	£4,012,500	£4,012,500
Four per cent. cumulative preference shares of £5 each	1,000,000	1,000,000
Five per cent. non-cumulative second preference shares of £1 each	2,000,000	—
Four per cent. mortgage debenture stock	2,500,000	2,500,000

Largely through the efforts of Mr. M. J. Butler, of Montreal, was the company induced to locate a plant in the Dominion. He was successful in interesting their board of directors, however, only through the kindly co-operation of Sir Percy Girouard, a Canadian, and a director of the Sir W. G. Armstrong Whitworth and Company, Limited. To these two gentlemen, therefore, is chiefly due the establishment in Canada of such an important industry. Mr. Butler is well known as the former general manager of the Dominion Steel Corporation. Prior to that, he was chairman of the board of management of the Canadian Government railways, and previously deputy minister and chief engineer of the department of railways and canals. He is a member of several engineering societies, and has been engaged in some notable engineering projects in various parts of the Dominion. A contemporary recently described him as a man possessing "keen business instincts, systematic methods of work and all the firmness of the disciplinarian,"

Sir Percy Girouard was born in Montreal and gained his railway experience while on the engineering staff of the Canadian Pacific Railway. He acted as director of the Soudan Railways from 1896 to 1898. He was also president of the Egyptian Railway Board and later director of the railways of South Africa. As a military man he has served with honor in many engagements. Lord Kitchener described him as an officer of brilliant ability, and Lord Desborough has stated that he is a great civil servant who has succeeded in every position he has undertaken.

Oiling grade crossings so as to prevent a dust nuisance is being regularly practiced on the Delaware, Lackawanna & Western R.R. Two equipments are in use in different parts of the line, each consisting of an oil car provided with compressed-air tanks and special nozzles for spraying the oil. These cars are drawn along the line, and the crossings are oiled in succession by a crew that goes with the car, so that each crossing is oiled about twice each year. It has been found that this procedure is successful in keeping down the dust to such an extent that there is no offense from that source to passengers, particularly to those on rear-end observation cars, where before the oiling the nuisance had been great.

Mr. Frank Shuman, a distinguished American engineer, has installed near Cairo, a hundred horse-power sun plant for irrigation, and he has left London for Egypt to complete the installation and to begin operations almost immediately.

Four times only in the history of the human race has the generation of power been the subject of invention. First came the windmill, then the water-wheel. The third departure, and the greatest so far, was the combustion of fuel. Now comes the use of the solar rays, which, if successful, will be the most complete revolution of all, solving at once for the tropics the problem of fuel, which in the past has been so great a handicap to remunerative labor, and which in the future, with the diminishing supplies of coal, must become a greater handicap still.

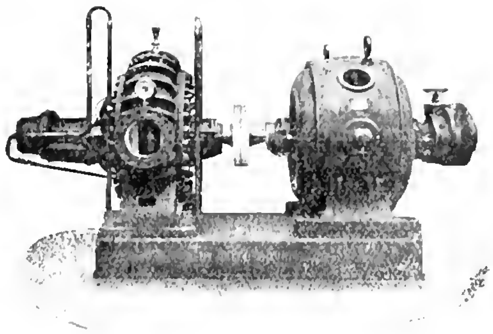
Explaining the character and purpose of his sun-power plant, Mr. Shuman said that "by means of parabolic mirrors the heat of the sun is concentrated to five times its natural intensity.

"This gives us a temperature of about 600 deg. Fahr., and by means of this heat concentrated on boilers the steam is generated, which is used for driving a low-pressure condensing engine. This engine in turn drives a large reciprocating pump capable of pumping 13,000 gallons a minute, and thus irrigating in this particular locality 1,000 acres of land

AN EFFICIENT HYDRAULIC PUMP.

The accompanying photograph shows a view of the "Victoria" hydraulicking pump. It is one of these pumps which was supplied to the Nipissing Mining Company. The pump, as shown, delivers 4,000 gallons per minute against a head of 415 feet, and has a speed of 1,180 revolutions per minute.

Details of the test made of this pump under actual working conditions will be found on the table accompanying this article, from which it will be seen that the efficiency in normal working reached 84 per cent. Boving & Company, Limited, who are the designers and manufacturers of this pump, and who are represented in Canada by Canadian Boving Company, inform us that similar pumps of various sizes have been sent to different parts of the world. It is interesting to note that the "Victoria" pump has the impeller automatically balanced, which obviates the necessity of a high-pressure stuffing box. One of these pumps installed at the Goss Moor tin mines has effected a great saving over the pumping methods previously used. The results obtained at Goss Moor are shown herewith and speak for themselves. The Victoria pump has been designed especially to overcome the difficulties experienced where water containing a large amount of mud and grit would cause heavy wear and tear. That it has done this effectively may best be seen from the results obtained in actual practice.



Some test results as obtained in the Goss Moor pump after it had been running for some time are given herewith. The engine is of the compound type, 11 in. x 19 in. cylinder diameter, 2 ft. 6 in. stroke, built by Messrs. Marshall.

Official Test Figures of Victoria Pump Supplied to the Nipissing Company.

No. of test	Pressure of pump	Vacuum	Total head	Speed R.P.M.	Water rise	Time for rise	Imp. galls. per min.	U.S. galls. per min.	Pump H.P.	Volts	Amps.	Kilo-watts	Elec. H.P.	Overall efficiency
1	174	12"	416.1	1,183	8.45'	126.5 sec.	3,850	4,620	485	2,155	149½	500	670	72.4
2	174	12"	416.1	1,183	8.45'	127.5 sec.	3,820	4,580	481	2,150	150	500	670	72.1
3	171	12"	408.44	1,179	8.40'	121.8 sec.	3,970	4,765	492	2,145	153	500	670	73.4
4	171	12"	408.44	1,175	8.25'	121.8 sec.	3,910	4,690	485	2,160	150	500	670	72.4
5	171	12"	408.44	1,175	9.1'	132.8 sec.	3,950	4,740	490	2,140	151	500	670	73.1
6	172	12"	410.75	1,184	9.0'	130.4 sec.	3,970	4,765	494	2,168	152.5	500	670	73.7
7	170	12"	406.6	1,181	7.6'	107 sec.	4,080	4,896	501	2,150	142	500	670	74.8
													Average:	73.1

Speed of pump	Pressure in lbs. per sq. in.	Vacuum at pump inlet	Vertical distance	Total head in feet	Quantity discharged. gal. per min.	Engine speed	Indicated H.P. Pressure high	Indicated H.P. Pressure low	Water H.P. I.H.P.	Approximate efficiency of Victoria pump
628	47	3"	5'	116.4	3,460	116	111	52.5	74.5	85%
628	—	—	—	116.4	3,460	116	—	—	74.5	
628	—	—	—	116.4	3,460	115	—	—	74.5	
630	47.2	—	—	46.9	3,460	116	—	—	75	

The pressure readings were taken with test gauge on the top of the horizontal discharge of the pump. The pressure was very unsteady, the pointer vibrating about 5 lbs. The average is entered in the above table.

The vacuum readings were taken on the top of the horizontal suction pipe. The vacuum fluctuated about ½ inch to 1 inch during all tests.

The water was measured in a circular tank of 14 feet inside diameter, and the discharge from the end of the pipe was diverted into the tank by means of a "bucket" mounted on a truck. The truck was running on rails and the flow could thus be diverted very quickly. The results obtained on the amount of water discharged are very accurate, as there was no leakage or waste of water whatever. The time of diverting the water into the tank was measured by a stop watch.

The volt and ammeter readings were taken by the switchboard instruments, the kilowatt was taken by means of a standard instrument mounted on the switchboard. The total consumption during two hours continuous running was 1,000 kw. hours, corresponding to an average consumption of 500 kw.

At the National Physical Laboratory in England, there is a recently constructed road machine, which is the first of its kind in any country. It is a building containing a circular track on which experimental lengths of road can be readily laid down and tested to destruction by the passage over them of wheels driven by motors which are guided in the circular track by a revolving framework.

The machine is now at work. The track has been filled with four lengths of water-bound macadam made up in four different ways and the behavior of these lengths will be compared and each of them tested until it is broken up. The designers hope that by means of this machine they will be able to arrive rapidly at conclusions which otherwise would take years to reach on the actual roads themselves. The roadway is under cover and protected from weather influences, thus eliminating weather conditions entirely. It will be possible to introduce certain weather conditions one at a time and to study their individual effect.

For instance, the track can be heated by hot air blown upon it; rain can be imitated by spraying devices; it can be artificially cooled to the freezing point. The wheels used can be either standard wheels with plain steel tires carrying a fixed weight of one ton each; the diameter and widths of these wheels can be varied; solid rubber tires or pneumatic tires, plain corrugated or studded, can be substituted in turn and the effects of each on a road surface noted.

COAST TO COAST.

Toronto, Ont.—There is a tendency in some counties to distribute the county road work each year in short sections, rather than to take up one road and build it from end to end, according to Mr. W. A. McLean, Chief Engineer of Highways for Ontario, in his recent report. Work is scattered in this way for various reasons. Each councillor is ambitious to have some work done in the township he represents; there may be a fear that certain ratepayers will become dissatisfied if all the work is done in another locality; that the total expenditure may become exhausted before all roads are reached; there may be a desire to let all sections in the county see the class of work done on the roads, and to receive some early benefit; a wish to construct a section of road that is especially bad, or is largely travelled. The tendency is greatest in counties where there are numerous market centres or shipping points, and less in the counties with one well-defined centre, such as York with roads radiating from Toronto, Wentworth with Hamilton as a leading market, or Prince Edward with much traffic leading to Picton. To build roads in short sections in some cases may serve a useful purpose, but the practice is an expensive one and adds largely to the cost. Road-building is almost entirely a work of labor, and it is essential to economy that a well-arranged organization be created. It commonly takes a month to build a mile of road, and takes nearly that time to get the work going smoothly. To move the plant and equipment from place to place for every mile of road means that the work will be kept in constant disorganization, that laborers and teamsters who have become accustomed to the location will leave, and new men will take their place, that much time will be lost in moving the machinery from place to place while wages are still going on. Every move made means a loss of efficiency, loss of time, useless expenditure for wages, fewer miles built and a much increased cost. Short sections are justifiable and necessary in some cases, but to carry work on in that way as a fixed practice involves a useless increase of cost. The necessarily increased cost of "model roads" is not an expenditure which counties should assume.

Port Moody, B.C.—Preparations for the early construction of a sewer system will shortly be made. At a recent meeting of the city council the aldermen decided that a topographical survey of Port Moody would be advisable before undertaking the planning of a sewer system or its construction. This topographical survey will be made to ascertain the levels and the best location of main and lateral sewers, as well as outfalls and other details of their construction. From information gathered from this survey the council will be in a position to decide on the advisability of constructing a separate system of storm sewers or combining the two systems into one general scheme of drainage. Other statistics will be gathered by the engineers, who will do this work, and when the council is ready to lay out the system, the engineers will be prepared to give an accurate estimate of the cost of the entire system. The construction of a sewer system will, of course, follow the installation of the waterworks and the extension of this system.

Montreal, Que.—A model of the city filtration plant is under construction at Verdun on land of the same nature as that on which the ill-starred plant has its site. The model will be a replica of the plant in every important detail. Its pillars have been designed to carry a pressure of 2¾ tons a square foot—which is approximately the pressure exerted by the pillars of the plant. When the model is completed, the action of the soil will be carefully observed and minute tests taken of its power of resistance to pressure. The tests on the nature of the soil are the result of the protest which Norman McLeod, contractor for the construction work of the plant, recently filed with the city. Mr McLeod claimed the soil had an insufficient resisting power, causing the pillars to sink and a consequent upheaval of the concrete beds. The engineers for the city, on the other hand, contended the damage was due to the work not being properly protected from the effects of frost.

Victoria, B.C.—To construct the north-west sewer system of sufficient capacity to take care of a drainage area of 775 acres in Saanich, and approximately 1,000 acres in Esquimalt and make the proposed city system adequate for the future requirements, not only of that portion of the city alone, but also for the greater area covering the north-west section of the three municipalities, will cost in the neighborhood of $325,000, according to figures submitted by City Engineer Rust to the city council. The construction of the city system, including the main trunk outlet through Victoria West and on out to Macaulay Point will cost $240,000. To make this outlet sufficient for Saanich requirements in that section would mean an addition to the cost of $42,000, and to provide Esquimalt also with outlet facilities will mean a further expenditure of $43,000. The Saanich area addition would mean facilities for a population of about 11,000 and the Esquimalt addition for about 20,000. On the recommendation of the engineer, the two other municipalities will be approached with a view of coming to a mutually satisfactory agreement relative to the joint expenditure to provide larger accommodation, and also to an annual rental for use of the sewer. Esquimalt will be asked to grant permission to the city to drain ninety acres of surface water into the former municipality's surface drains which it proposes to construct. If this is done it will obviate the necessity of the city constructing a surface drain in the proposed sewer tunnel. City Engineer Rust stated that the engineers of Esquimalt and Saanich have practically agreed upon the plans of the proposed sewer system, but that the arrangements as to cost must be taken up by the respective municipal councils. Pending the submission of the scheme to the ratepayers of Esquimalt and Saanich, a tentative agreement could be arrived at. If the outside municipalities do not fall in with the proposed scheme, it would cost them in the neighborhood of $200,000 to provide an adequate sewer system for themselves.

Toronto, Ont.—Parks Commissioner Chambers hopes to make a start this summer on the construction of a complete system of boulevards, forty-two miles long, costing $7,000,000, and reaching around the city. The Parks and Exhibition Committee have appointed a sub-committee to make a trip over the proposed route, which is as follows: Lakefront, from Woodbine to the Humber, north up the Humber to Black Creek, east to Vaughan Road, north to York Mills, south through the Don Valley to the junction of the north and west branches of the Don River, east to Woodbine Avenue and south on Woodbine to the starting point at Woodbine Avenue and the lake front. The plan proposed would connect all the important parks in the city, in addition to many beauty spots in the county. The committee also decided to visit Hanlan's Point and look over the route of a 66-foot roadway it is proposed to construct along the west shore of Blockhouse Bay, from the Hanlan Memorial Park to a point near the Lakeside Home, a distance of 2,400 feet. The plan does not interfere with the waterfront development work contemplated by the Harbor Commission, and it is believed the road would relieve the congestion that always exists on the lake front on holidays and Saturdays. The cost of the work has not yet been estimated.

PERSONAL.

MR. F. S. B. HEWARD, Canadian manager for James Howden & Company, Limited, Glasgow, was in Toronto this week on a business trip.

M. W. SPARLING, B.A.Sc., has recently accepted a position at Campbellford, Ontario, as superintendent of the Seymour Power and Electric Company.

MR. ARTHUR C. HEAP, of the firm of Heap & Digby, inspecting and consulting engineers, of London, England, was a visitor to *The Canadian Engineer* offices this week.

Following the visit of Mr. G. B. Hunter to Canada, MR. WIGHAM RICHARDSON, of the celebrated Tyne shipbuilding firm, Swan, Hunter, Wigham Richardson, Limited, is now on a tour through the Dominion.

MR. WILLIAM STORRIE, acting waterworks engineer of Ottawa, has handed in his resignation, to take effect on July 1st, next. His two assistants, Messrs. H. M. Lee and T. C. Campbell have also resigned their positions.

R. G. SWAN, B.A.Sc., of Vancouver, B.C., has been appointed assistant chief engineer, Railway Belt Hydrographic Survey, of the Water Power Branch of the Department of the Interior, with headquarters at Kamloops, B.C.

W. A. McLEAN, provincial highway engineer for Ontario, and W. G. HENDERSON, president of the Manitoba Good Roads Association, were entertained at luncheon by the York Highway Board previous to their departure for Europe.

H. E. M. KENSIT, Mem. Inst. E.E., Mem. Am. Inst. E.E., electrical mechanical engineer of the Water Power Branch of the Department of the Interior, has accepted an appointment as Commissioner of the City of Prince Albert, Saskatchewan.

The appointment of J. T. JOHNSTON, B.A.Sc., as hydraulic engineer of the Water Power Branch of the Department of the Interior, with charge of water power surveys, investigations and inspection work in Manitoba, Saskatchewan and Alberta, has been gazetted.

MR. JAMES C. HARDING, consulting engineer, has opened an office at 170 Broadway, New York City. Mr. Harding has been engaged in the practice of hydraulic and sanitary engineering for the past 21 years, and has been a member of the firm of George W. Fuller for the last two years.

MR. JOHN S. MacLEAN has been appointed to take charge of the publicity and advertising work of the Canadian General Electric Company, Limited, and of the Canadian Allis-Chalmers, Limited, with headquarters in Toronto. The latter company, in addition to manufacturing an extensive line of machinery and appliances, will also act as sales agents for all the products of the Canada Foundry Company, Limited. Mr. MacLean held a similar position with Allis-Chalmers-Bullock, Limited, for a number of years.

MR. CHARLES B. BUERGER has joined the staff of Mr. George W. Fuller, 170 Broadway, New York City. Mr. Buerger entered the service of the Bureau of Filtration at Philadelphia in 1906 as a mechanical engineer, and was engaged upon the design, construction and testing of pumping stations and equipment. Later he was on the design of the preliminary filters at Torresdale and Belmont and had charge of the design of the Queen Lane filter plant. For the past two years he was senior assistant engineer in the Filtration Division of the Department of Water Supply in New York City on the design of Jerome Park filter plant.

ARTHUR H. BLANCHARD, M. Can. Soc. C.E., professor of Highway Engineering in Columbia University, sailed on June 12th to attend the Third International Road Congress, London. Professor Blanchard is a United States reporter on Question 3, "Construction of Macadamized Roads Bound With Tarry, Bituminous, or Asphaltic Materials," and Communication 10, "Terminology Adopted or to be Adopted in Each Country Relating to Road Construction and Maintenance." He has been appointed a delegate to the Congress by Columbia University, the American Society of Civil Engineers, the National Highways Association and the American Road Builders' Association.

MR. H. O. EDWARDS, who for the past twelve years has been advertising manager of the Canadian General Electric Company, Limited, and its subsidiary companies, has resigned. Mr. Edwards organized the advertising department of that company in 1903 and since that time has taken charge of all advertising, publishing of catalogues and technical bulletins as well as the purchasing of office supplies, stationery, etc. Mr. Edwards is to become sales manager of the Photo Engravers, Limited, 70 Bond Street, Toronto, where, no doubt, his long experience in the purchasing of engraving will serve him in good stead.

NOTICE OF EXHIBIT.

At the annual meeting of the Society for the Promotion of Engineering Education, which will be held in the Engineering Building of the University of Minnesota, Minneapolis, Minn., during the week beginning June 23rd. W. and L. E. Gurley, of Troy, N.Y., will have a representative exhibit of the instruments which they manufacture and which will include engineers' and surveyors' field instruments, water stage registers and current meters, physical and electrical laboratory apparatus, standard weights and measures, accurate mercurial thermometers.

Engineers and others interested will find that a visit to this exhibit will repay them, as an opportunity will be given to inspect the latest improvements in the instruments and to talk with the firm's representatives.

TENTH ANNUAL AMERICAN ROAD CONVENTION.

The American Road Builders' Association will hold its tenth annual Convention and fourth American Good Roads Congress in Philadelphia, December 9th to 12th, 1913.

The annual meeting of the Association is of great interest to those actively interested in road construction and maintenance. It always brings together the leading men identified with road building and street paving, for the purpose of discussing the problems in which they are vitally concerned. Plans are now being laid to make the Philadelphia meeting the largest and most important gathering of the kind ever held. As usual, there will be in connection with this meeting an exhibition, or rather exposition, of road and paving machinery, materials, etc.

The American Road Builders' Association was formed in 1902, and is the foremost organization of its kind in the world. Among its members are the leading road and paving experts, highway officials, engineers and contractors in America. The president of the association is Mr. Samuel Hill, of Seattle, Washington, who is also life president of the Washington State Good Roads Association, and is also identified with other good roads organizations. The other general officers of the association are as follows: First vice-

president, Mr. Harold Parker, ex-chairman Massachusetts Highway Commission; second vice-president, Mr. W. A. McLean, Provincial Engineer of Highways of Ontario, Canada; third vice-president, Mr. George W. Tillson, Consulting Engineer Borough of Brooklyn; secretary, Mr. E. L. Powers, editor "Good Roads;" treasurer, Mr. W. W. Crosby, Consulting Engineer.

AMERICAN SOCIETY FOR TESTING MATERIALS.

The sixth annual meeting of the American Society for Testing Materials will be held at Atlantic City, N.J., June 24th to 28th. A provisional programme has been arranged, according to which the following subjects will be discussed: "Preservative Coatings," "Steel," "Wrought Iron," "Cement, Concrete and Waterproofing," "Ceramics and Road Materials," "Non-Ferrous Metals," "Testing Apparatus and Methods."

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson. Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. H. W. Claudet S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.

Volume 24 Toronto, June 26, 1913 Contents of this issue on page 915

The Canadian Engineer

An Engineering Weekly

PLATE GIRDER BRIDGES IN RAILWAY CONSTRUCTION

PART I

PREVALENCE DUE TO ADVANTAGES OVER OTHER DESIGNS —TYPES OF PLATE GIRDER SPANS IN USE—DIMENSIONING AND STRESS CALCULATION—VARIETY OF LOADS

By C. H. MARRS, C.E.
Erecting Engineer, Hamilton Bridge Works Company, Hamilton, Ont.

THE builders of iron and steel bridges for more than sixty years have maintained that steel bridges properly designed, with good material, efficiently maintained, and used according to the intention of their designers, have in every case proved entirely satisfactory and capable of indefinite endurance and that any cases of disaster have been due to some defect in the construction, to derailment, or other accidental occurrences which bring upon certain members unforeseen strains which they were not intended to carry.

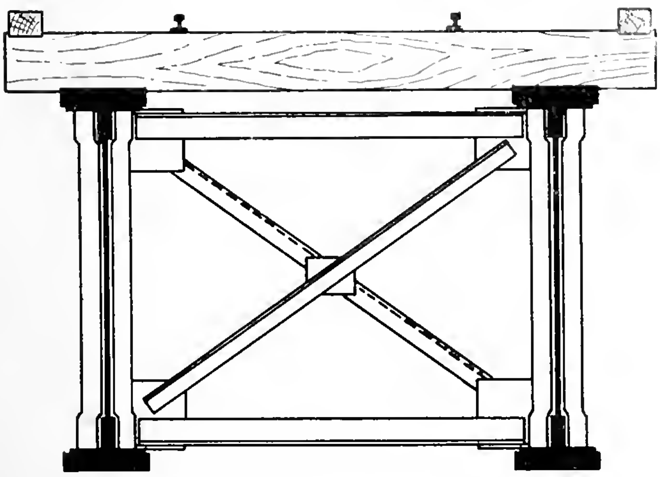


Fig. 1.—Type of Deck Plate Girder.

Of all types of steel railway bridges the plate girder span is the most common, as 75% of the extensive mileage of bridges built, is in the form of plate girder spans, and it is this great commercial demand which has suggested to the writer the importance of this subject.

Canada is still in her infancy in railroad construction, and in the future it will be necessary for a great many of our young engineers to have charge of the design and fabrication of plate girder bridges. Shop methods and erection facilities have so changed that text books do not give the young engineers all the information they require. It is not the object of this series of articles to explain the fundamental theories of plate girders, but to treat the subject from the standpoint of an engineer in actual practice, and to give an intelligible explanation of various snags which are not covered in text books, and which are either omitted in different specifications, or upon which they do not agree.

The advantages of plate girder construction over other forms of bridges are so evident that it is used wherever conditions will permit. One of these advantages is its solidity, by reason of which it is better fitted to resist injury from derailed trains, to prevent corrosion from sulphur gases, and to withstand the severe conditions of exposure which pertain to railway bridges. Another reason for the superiority of this form of bridge is its simplicity and uniformity of construction, there being a minimum likelihood for error in design. Moreover, the drawing-office expense and shop costs are reduced, as it is usually possible to standardize spans. The erection is completed in a shorter time than in the case of any other form of construction. There is usually more weight of material required in plate girder bridges than in lattice or truss spans, but this objection is more than counterbalanced by its cheaper pound price, the greater speed in the completion of the work and the longer durability in actual service.

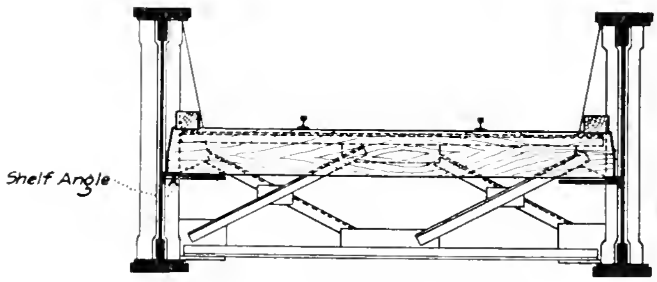


Fig. 2.—Half Deck Plate Girder.

The design of a bridge may be divided into two branches; first, the determination of the type of bridge most suitable and its dimensions, and second, the calculation of stresses and sections of material. After the site of the proposed bridge has been surveyed and the engineer has determined the grade alignment of the track, the allowable depth of clearance line below the base of rail and the most suitable lengths of spans required, the design of the bridge can be attained.

Types.—The various types of plate girder bridges which are in general use at present are represented in Figs. 1, 2 and 3, the deck girder being the cheapest and simplest form and therefore used wherever conditions of clearance will permit. Where the allowable depth for clearance is reduced to the limit where a deck span would not suit, it is necessary to adopt the half deck girder, as shown in Fig. 2, or the through plate girder type, as shown in Fig. 3. The half deck girder span is very little heavier than the deck span and is frequently used where the top flange is not more than three feet above the base of rail, the main girders being spaced 13 feet between centres. There have been bridges built where the shelf angles have been lower than this, and in some structures the ties have been made to rest directly on the bottom flange. This is not good practice, as it is necessary to space the girders further apart to suit the recognized requirements of clearance, and this would demand longer and

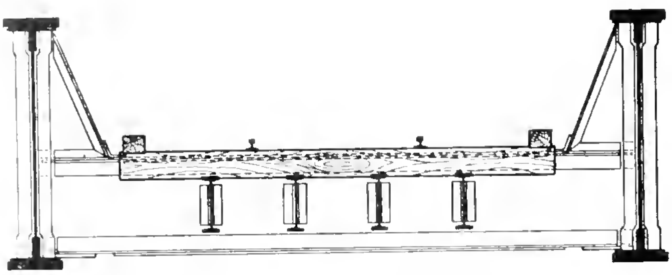


Fig. 3.—Through Plate Girder.

heavier ties and, moreover, the cross brace frames become so shallow that it is not possible to properly stay the top flanges of the main girders. The greatest objection to the half deck girder is that the ties resting on shelf angles must produce eccentric loading on the main girders, and this is not easily taken care of. The half deck span also requires extra heavy ties with an odd length, and these ties demand the most rigid inspection on account of the severe strain they undergo, and when it is necessary to replace them the procedure is much more difficult than in the case of the other types of girders because the ends of the ties butt into the webs of the girders.

The through plate girder span with stringers and floor beams, is undoubtedly the most desirable construction, where the depth of clearance is limited. Fig. 3 is an example of this form of bridge and shows four lines of stringers per track, which arrangement is considered to be better suited to support derailed trains, and which requires only a very light tie. But it is a cheaper construction, and quite as satisfactory, to use two lines of stringers per track.

In the case of railway bridges passing over streets in cities, where very shallow construction is an advantage, and where protection is needed for the street traffic, a solid floor is used. This may be accomplished by I-beams with a continuous cover plate, or by trough floor construction covered with a waterproofed concrete slab and ballast. The best type of trough floor is shown in Fig. 4. It is an expensive bridge and is not in very common use in Canada, but as railroads multiply in the larger cities it will be more necessary. The trough floor can be made shallower than any other type of floor for heavy loads, and is free from the noise of passing trains, which is an objection in more open construction.

Another type of solid floor, which is illustrated in Fig. 5, is being used in Canada by several railroads, even on bridges where protection below is not needed. It consists of regular track ties in ballast supported on concrete, which covers and fills in between the cross I-beams over the main girders. This construction is being used because of the scarcity of good large bridge ties, and the expense which is frequently required to replace these ties. Any construction which decreases the demand for timber is to be recommended, and there is a probability that bridge design may be considerably changed to suit the increasing scarcity of bridge ties.

There are some tube bridges still in existence, but they are not recommended in modern construction; nor is any form of box girder desirable where the inner surface is not accessible for painting. Wherever a box girder is used, it should be properly braced with diaphragms, so that it will not change its rectangular shape.

Dimensions.—In single spans the effective length of girders is dependent on the adopted clear opening between the abutments, as the edge of the masonry bearing plate should be six inches back from the face of masonry under coping. The length of the bearing plate can then be decided by an approximate calculation of the maximum end reaction. If the final calculations should give a slightly different required area of bearing plate, the difference can usually be taken care of in its width. The effective length of girders is the distance between the centres of these end bearing plates.

In bridges consisting of a number of spans resting on masonry piers, spaced at the most economical distance, the clear space between the ends of main girders should not be less than four inches, and the effective length of the girders is dependent upon this. In steel trestles where the girders rest on towers, the ends of adjoining girders should be placed as close together as the possible expansion will permit, and the effective length will depend on the adopted detail of seat, resting on the cap of the tower posts. In this construction, where the adjoining spans are of different lengths, the different end reactions will produce eccentric loads in the posts, which should not be neglected in the design.

The effective depth of main girders, which is the distance between the centres of gravity of flanges, is usually made to vary from ⅛ of length of span, for short spans, to 1/12 of length for long spans. If, for reasons of clearance, it is necessary to make the depth less than 1/12 of span, additional metal should be inserted so that the deflection will not be more than it would be with the above-mentioned depths. In bridges designed for very light traffic, it is more economical to use shallower girders.

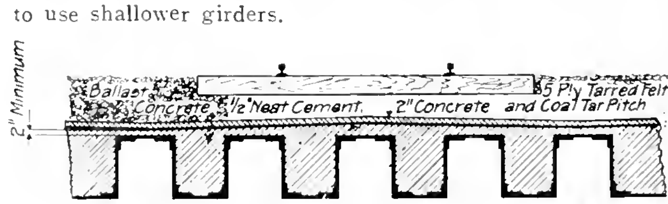


Fig. 4.—Cross Section Through Trough Floor.

There is a diversity of opinion among railroad engineers regarding the best spacing centre to centre of deck girders. This spacing consequently varies from 6½ feet for short spans to 10 feet for longer ones. Where the track is on a curve this spacing should be increased to accommodate the deviation of the track and to give additional stiffness to resist the centrifugal force of the trains.

Through girders are spaced as close together as the government clearance requirements will permit, and when the track is on a curve, this spacing is increased in proportion to the degree of curvature. A simple method of determining this required clearance is indicated in Fig. 6 and its accompanying explanatory note.

Skew in bridges should be avoided wherever possible, but it is sometimes necessary. It is less objectionable in girder spans than in trusses. Even though skew in the face of abutments is necessary, the ends of the girders should be

made square to the track, as this is a better arrangement for the deck. The character of the skew is termed right-handed when it is in the direction shown in Fig. 7.

The depth of the deck is the distance from the base of rail to the top of the girder, and when the track is on a tangent this depth is ½-inch less than the depth of tie required to support the wheel loads. Fig. 8 illustrates the C.P.R. standard track for deck girder bridges, and it shows the methods of securing the deck to the girders, and the amount of material required. When the track is on a curve, the base of the low rail is referred to in giving the elevations. The outer rail is given a super-elevation to suit the degree of curvature. This is usually made to suit a medium speed of train, rather than a maximum, as the rails are considered to wear longer with this arrangement.

This super-elevation may be arranged by tilting the whole bridge until the webs of main girders are normal to the plane of the track. By this method the standard deck can be used, similar to the case where the alignment of the track is tangent. This arrangement gives a minimum side thrust at the top flanges where the ties rest on the girders, and also a minimum strain on the bracing, because the direction of the axis of the bridge is midway between the vertical direction of the load, when the train is moving slowly, and the direction of the resultant force of the train at high speed. The more general practice, however, is to place the girders in a vertical position and provide for the super-elevation of the track in the framing of the ties. With this arrangement the bridge has a better appearance as well. The cheapest arrangement of the deck is to use regular ties with wood shims on the outer girder to provide super-elevation, but this is dangerous practice and should not be used. The best construction is the use of bevelled ties which can be detailed in the drawing room and ordered to suit. In this arrangement the depth required for the deck depends on the minimum depth of ties, over the inside girder, that is considered necessary to properly resist the shear stresses in the ties. This depth should never be less than 6½ inches, the worst position with the track on a curve being at the centre of the

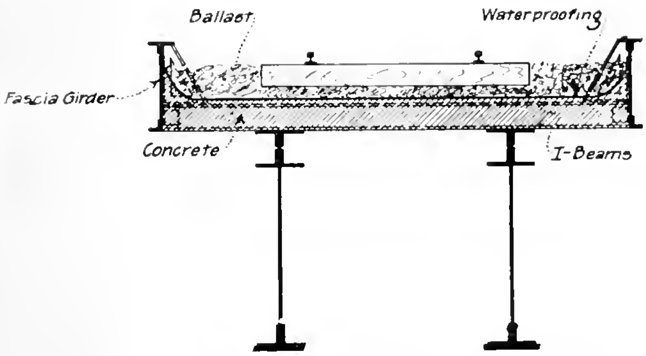


Fig. 5.—Cross Section Through Solid Floor I-Beam Construction.

span, where the camber is the greatest, the cover plates the thickest, and the lower rail farthest from the inside girder. So that if the depth of deck is decided at this point, the ties will have a greater depth towards the end of the span.

It is a common occurrence for engineers who do not correctly foresee the depths required for bridges, in the deck, in the girders themselves, and in the pedestals, to make mistakes in the construction of the masonry; and to overcome such errors it is often necessary to belly the bottom flanges of girders at the ends. This costs the contractor at least $200 a span for the steel, and is usually a total loss to him.

Camber.—This allowance is usually insisted upon for plate girder spans. The intention is to put sufficient camber in the span to more than overcome any possible deflection from loading, because a girder constructed straight might have a reverse camber when erected, which would have an unsightly appearance. A great many bridge engineers consider that this is unnecessary refinement, but if it is specified, good results can only be obtained by proper details and rigid shop inspection. Cases are known where two girders on the same span have reverse camber, although built from the same drawings and in the same shop. Another difficulty in regard to camber is in double track bridges when one track

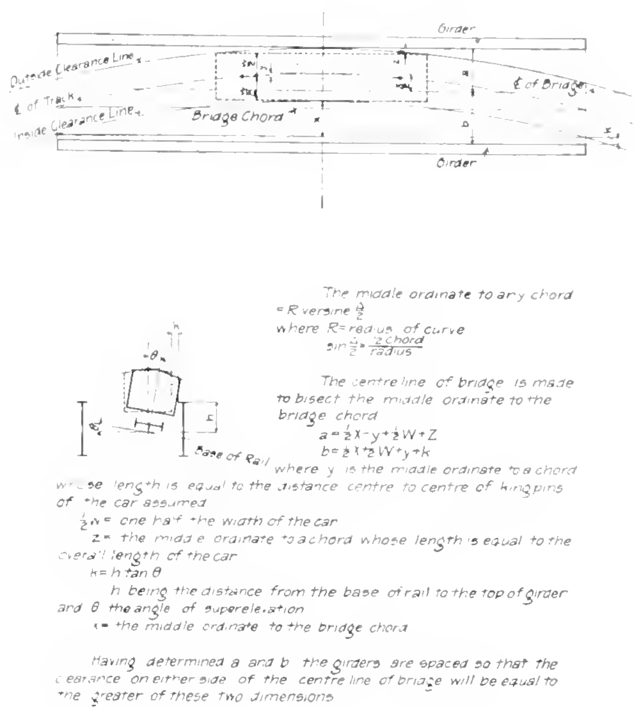


Fig. 6.—Clearance in Through Bridges on Curves.

only is loaded. Where there is one centre girder there is more deflection in the outer and lighter girder and where there are only two main girders there is more load carried by the one girder than the other, and therefore unequal deflection exists. The only arrangement to avoid this difficulty is to place two girders under each track, as if they were separate spans. This is a more expensive arrangement, but it is the best design, because the wear and tear on the bridge is lessened and each half is free to move and deflect by itself when loaded, without straining the other half which would probably be unloaded. It is often an advantage, too, in erection, as one track can be completed first, without interrupting traffic on the other track.

Calculation of Stresses.—In plate girder spans, as in all types of railway bridges, this calculation is based on the following loads: 1, dead load; 2, live load; 3, impact; 4, wind stresses; 5, centrifugal force when track is on a curve, and 6, traction. The methods, both analytical and graphical, for obtaining the dead and live load stresses, are fully covered in all text books on this subject and universally recognized in practice. As these basic methods are unaffected by evolution in construction it seems unnecessary to consider them here.

The dead load per lineal foot of track must be assumed to begin the calculations. It consists of the weight of material in the deck and the steel in the structure. In determining the deck it is usual to consider first the maximum axle load plus impact, distributed over three ties. This will determine the size of ties needed, and as the rails and guards and fastenings are standard, the weight of the deck is then

known. The weight of the steel must be assumed either by approximate methods or from records of weights of other spans, and when the design is completed a check should be made to make sure that these assumptions agree with final results.

The live loads adopted by various railroads are usually standard types of consolidated engines followed by a uniform train load and an alternate heavy concentrated load, and the different classes of loading are provided for by varying the loads in the same proportion throughout the whole train. In this way the calculations of stresses are simplified and the results are quite satisfactory, as it is impossible to foresee in every case the exact wheel loads which may be carried by the bridge. Moreover, by the adoption of this standard loading, tables of shears and moments for deck spans of various lengths can be made, which save time and labor in actual practice. In through bridges it is always necessary to calculate each bridge by applying the actual wheel loads.

Impact stresses should always be added to provide for the momentum of the live load caused by deflection of the bridge, the unevenness of the track, vibrations, and various other conditions, but the amount of this impact is always a stumbling block to bridge engineers, as shown by the number

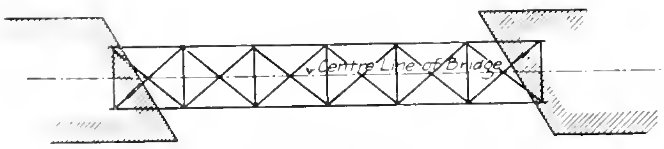


Fig. 7.—Right-Handed Skew, Showing Bridge With Ends Square.

of different formulae in use. The intensity of this impact depends on the length of span under load, the proportion of dead and live loads, the elasticity of material and other causes which are unknown, and it is imperative that practical experiments be made on all types of bridges to determine a formula for impact which will be reasonable and satisfactory. However, all formulae used at present are doubtless on the safe side.

The wind stresses in an ordinary plate girder span do not affect the sections of the main girders at all, because they are usually not considered unless they exceed 25% of the other loads combined. In plate girder bridges a moving load of 600 pounds per lineal foot of span is ample to provide for the wind on a moving train, for the oscillation of the train and for the wind on the bridge itself. This force will determine the wind stresses in the lateral system.

The centrifugal force of a train, when the bridge is on a curve, is not so important as the preceding stresses, but it cannot be neglected and should be considered, both in the laterals and in the main members. The equation $F = \frac{W V^2 D}{85700}$ gives the centrifugal force for a load W on a curvature of D degrees with a velocity of V miles per hour. It is considered to act in a horizontal direction, five feet above the base of rail and at right angles to the line of bridge. All engineers agree that the force F must be resisted by the lateral bracing in the same manner as the wind stresses, but they do not all have the same opinions of the stresses produced in the main girders. The best arrangement of a curved track on a bridge, is to place the axis of the bridge parallel to the chord of the curve, and to make the centre line of the bridge bisect the middle ordinate of the curve at the centre of the span. In other words, the deviation of the track from the centre line of the bridge is the same at the middle as at the ends of the span, and this is an advantage in the event of train derailment. Some bridge engineers are satisfied to consider that, with this position of the track, there will be practically the same load on both girders, and they only add centrifugal force stresses to the lateral system, and use the same girders for a track on a curve as for a track on a tangent.

A more general practice is to assume that there is an overturning action, and that in addition to one-half the live load, there is a load on the outer girder equal to $\frac{F h}{b}$, where F is the centrifugal force, h is the height at which F acts above the lateral system, and b is the spacing centre to centre of girders.

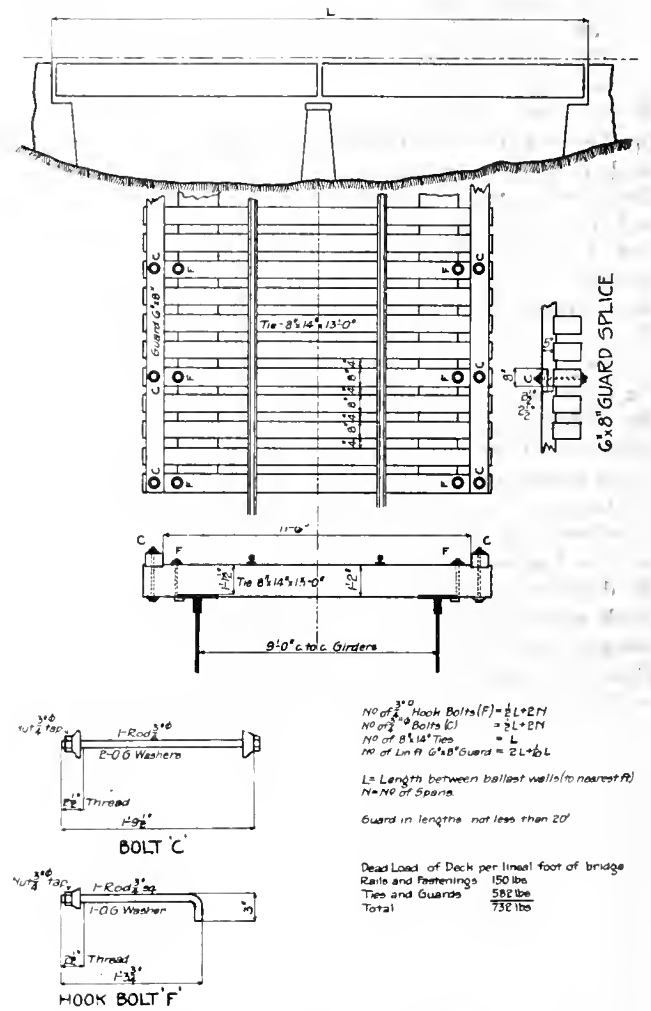
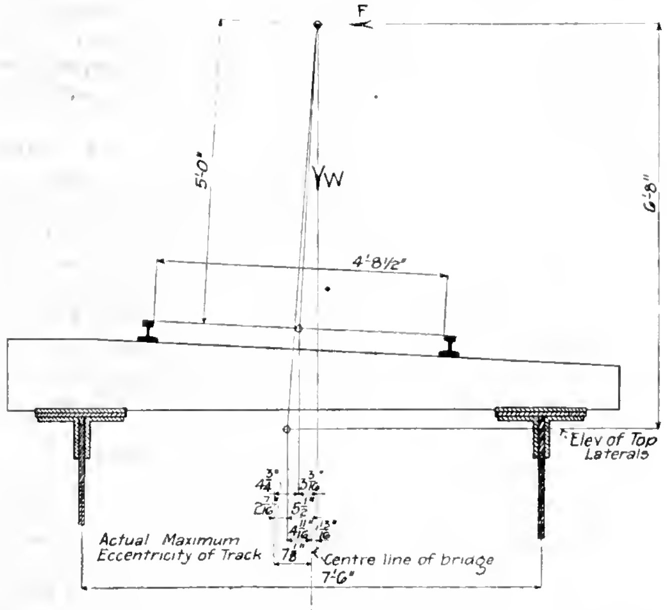


Fig. 8.—Standard Floor for Deck Bridges—Without Steel Floor Beams and Stringers.

Another practice is to consider that the eccentricity of the track at the centre of the span is constant over the entire length of the bridge. Then the proportion of the live load to be added to each girder is given by the formulae $W\left(\frac{M + b}{2 b}\right)$

Where W equals the live load, M is the centre ordinate to the curve, and b is the distance centre to centre of main girders. A thorough treatment of this subject is given in Fig. 9 and the data accompanying it. The theory applied in this example was advanced by Ward Baldwin, who is a college professor and a practical man, and perhaps the best authority on this subject in the United States. He was consulting engineer on a large viaduct in Cincinnati, which the writer designed. In this example the track is super-elevated to suit only a medium speed of train. On account of this arrange-

ment, neither the vertical direct load of a stationary train, nor the direction of the resultant force of a train at high speed, pass through the centre line of track, and these conditions are all taken care of in the calculations. Mr. Baldwin also finds the centre of gravity of the segment, and uses it as the effective position of the centre of the track throughout the length of the span for deck girders. He then arrives at the effective eccentricity for either a fast or slow moving train. The worst condition is used in the calculations, and both girders are made the same section. The extra load which is figured to come on one of the main girders is given as a percentage of the applied load. It is used in the stresses



Length of Chord = Overall length of Girder = 62'-0"
Arc = 62.06 ft Radius 406.424 ft
½ Versine = $7\frac{1}{8}''$ Elevation of Outer Rail = 3"
C G of Arc from vertex $\frac{.06}{62.06} \times 406.424 \times 12 = 4\frac{3}{4}''$
Required Eccentricity for Equalized Stresses, train standing $3\frac{3}{16}'' + 4\frac{3}{4}'' = 7\frac{15}{16}''$
Velocity of Train 30 feet per second
F = ·0688 W Couple due to F = ·0688 W x 80" = 5.504 W
Eccentricity due to F = −5½"
Required Eccentricity, train moving $= 7\frac{15}{16}'' - 5\frac{1}{2}'' = 2\frac{7}{16}''$
Actual Eccentricity = $7\frac{1}{8}''$
Effective Eccentricity, train moving $4\frac{11}{16}''$
Effective Eccentricity, train standing $\frac{13}{16}''$
Train moving, outer girder has excess $4\frac{11}{16}/90 \times W = 10.42\% \frac{W}{2}$
Train standing, inner girder has excess $\frac{13}{16}/90 \times W = 1.8\% \frac{W}{2}$

Maximum Bending Moments	Live Load	1,950,000	3,169,000
	Impact	1,219,000	
	Eccentricity	10.42%	330,000
	Dead Load		458,000
	Total		3,957,000

Assumed Loading L L Coopers E60
D L 1017 lbs per lin ft of Girder

Fig. 9.—Distribution of Loads for Bridges on Curves.

in connection with the live load plus the impact. The above method of determining the centrifugal force stresses, combines all the assumptions made by other engineers, and suggests new ideas which merit consideration. It was the first time, so far as the writer knows, that it had ever been used and it is the more interesting on that account.

The same theory applies in the calculations of the floor system and girders of through spans, with the exception that the position of the centre line of the track at the various panels is used in the calculations, and it is not necessary to assume an effective position of the track over the length of the bridge. In through bridges, too, the stringers should be made to follow the line of track as near as practicable.

When the track is on a spiral, the degree of curvature at the centre of the span is considered constant over the whole length of the bridge in figuring the centrifugal force.

The traction stresses are caused by the momentum of trains either starting or stopping, the amount being dependent upon the coefficient of friction between the wheels and the rails, which is usually considered .20. This force is not considered in connection with the main girders at all, but it does affect the lateral bracing in through plate girder spans. The best construction, to provide for this force, is to connect the bottom of the stringers to the lateral angles at the points where they cross, and to add a diaphragm between the stringers at these points, which will take the resultant of the stresses in laterals and stringers. This diaphragm will also act as a lateral support for the top flange of the stringers. The reason for the above detail is to prevent the traction from producing any horizontal bending moment in the floor beams.

NEW RECORD FOR GREAT LAKES.

A contract has been awarded by Montreal interests to the Western Drydock and Shipbuilding Company at Port Arthur for constructing the largest freight-carrying vessel ever built on the Great Lakes. It will have a capacity of 450,000 bushels of grain. Its length will be 625 feet; width, 59 feet; depth, 32 feet, with bulk-freight pattern, engines of latest type and of sufficient power to lead in speed, and Isherwood construction system, with five bulkheads, thus dividing the ship into six compartments. Work will commence this month and the vessel is to be ready for the 1914 season, operating between Port Arthur, Fort William and Collingwood, Ontario.

VANCOUVER HARBOR PROPOSAL.

The report of inspecting engineers on the feasibility of converting the harbor of Greater Vancouver into a strategic war base has been favorably considered by the British Admiralty in conjunction with representatives of the Canadian Government, according to the Manchester Guardian. The great increase in general shipping which is expected to take place at Vancouver renders it desirable that adequate measures for its protection should be taken without undue loss of time, and it is understood that when the permanent naval policy of Canada is announced a statement will also be made on the Pacific Coast defences of the country. There is already a naval base at Esquimalt, to the south of Vancouver Island, which possesses an admirable harbor with large docks and fortifications. The Government also have under consideration the question of establishing a naval base at Port Nelson, which is to be the tide-water terminus of the Hudson Bay Railway, a project that is to open up direct communication between Liverpool and the northwest of Canada, and to effect a saving in distance of 1,800 miles over the existing routes via Montreal, St. John and New York. Owing to this great natural advantage and to the fear, lately emphasized by the Canadian Minister of Public Works, that grain passing through the warm, humid climate of Panama would be in danger of heating, it is expected that vessels trading by the Hudson Bay route will have an immense advantage over those using the Panama Canal, and that in consequence the shipping interests of Port Nelson will rapidly develop.

WATER REQUIRED BY A STEAM RAILWAY SYSTEM.

In a report to the Illinois Water Supply Association, Mr. C. R. Knowles, general foreman of the Waterworks Department of the Illinois Central Railway, places emphasis upon the importance of an adequate supply of water of good quality for the maintenance of an economic and uninterrupted train service.

Not many years ago, the load of freight trains ranged from three hundred to five hundred tons, and an engine tender with a water storage capacity of twenty-five hundred gallons was considered ample: but to-day freight trains on important trunk lines of low gradients are loaded with two thousand to four thousand tons, and engines with tender storage capacity of nine thousand gallons are quite common. The consumption of water has, therefore, greatly increased and it has become necessary to raise the standard of water supply, both in quantity and in quality in order to meet the traffic conditions.

In former years it was the practice to erect a tank and establish a water station at any point where water of any kind was most convenient, with little regard for quality or future requirements. This has necessitated many changes to meet the changing conditions and added requirements, relocating the water stations with due regard to curvature, gradients and the many previously unknown expedients of operation.

To accomplish the desired result it is often necessary to pipe water from a considerable distance, or, if an ample supply is not otherwise available, to sink wells, or construct an impounding reservoir. If the available supply is not satisfactory in quality, it is often necessary to erect treating plants for converting it into a suitable water for locomotive purposes.

All these changing conditions and increased requirements have made it necessary to maintain a waterworks department organization, whose duties are similar to that of a city waterworks department. Constant vigilance on the part of this organization is necessary to maintain an uninterrupted supply of water at all times.

The amount of water required by a railroad 6,500 miles long, over the entire system, for all purposes, is approximately 16,500,000,000 gallons per annum.

Only part of the water consumed is metered, as a large part of it is furnished on a flat rate, or pumped by facilities, owned and operated by the railroad; consequently the figures given are estimated, the estimates being based on comparative figures at points where meters show the actual amount used.

The consideration of first importance in railway water supply, both in quantity and in quality, is water for locomotives. A water which would be ideal for this purpose would be one that would not scale, would not corrode, and which would not foam or prime. Unfortunately nature does not supply such a water; consequently, where these evils do not cause too much trouble they are tolerated and where they are excessive the water is treated. In the State of Illinois, on 2,000 miles of railroad, locomotives consume annually 4,236,838,000 gallons of water; 1,751,790,000 gallons of the above amount is purchased from municipal and privately owned waterworks plants, and 138,645,000 gallons is treated by purifying plants owned by the railroad company. It is necessary to maintain 123 water stations to distribute this water to locomotives at required points.

The washing and filling of locomotive boilers at terminals require a large amount of water in addition to the above, which amounts to approximately 950,000,000 gallons per annum. This is, of course, supplied through the same facilities supplying water for locomotives, with additional facilities for maintaining the desired pressure for washing and the necessary pipe lines for distribution of the water under pressure.

There is also the consumption of water by stationary power plants, including water used for condensing engines, which is approximately 300,000,000 gallons per annum, 125,000,000 gallons of this is city water. Water is also used for sanitary purposes at shops, roundhouses, offices and stations. This requires an additional estimated amount of 250,000,000 gallons, 200,000,000 gallons of which is city water. The grand total is 5,736,838,000 gallons used for all purposes in Illinois alone, 2,476,790,000 gallons of this is purchased from city plants.

It is interesting to note that forty-three per cent. of the water used in the State is purchased from municipal or private waterworks. It would seem that the railroads of the State form such a large portion of the various water companies' patronage that rates for water purchased from city plants could be made sufficiently attractive to secure even more of what would appear to be very desirable business. As a matter of fact the city rates in a great many instances are so high that the railroad companies wherever it is possible to do so have found it cheaper to install and operate their own stations.

The use of superheaters on locomotives, and modern washout plants, where the water is blown off from locomotives into the washout system and used again for washing and heating fresh water for refilling, have affected economies in the use of water, but the consumption of water has increased to such an extent on account of the larger business being handled that the result of these economies is not perceptible in the grand total of water consumed.

A great deal more might be said on this subject, but costs, merits of various sources of supply, methods of pumping, treatment and filtration have not been considered in detail, the object being to present the water supply of a railway system only in a general way.

ROYAL COMMISSION OF GEORGIAN BAY CANAL.

A Royal Commission will be appointed to investigate the commercial advantages of the Georgian Bay Canal project. Whether the Government will proceed with a twenty-two foot waterway from Montreal through to the head of the lakes via the Ottawa River and the Georgian Bay, or whether it will proceed to deepen the St. Lawrence Canal to a depth of twenty-two or possibly thirty-five feet will depend upon the report of the Commission.

One of the two or three interior terminal elevators to be erected by the federal government in the Canadian West is to be in Calgary. Placed as this city is at the natural gateway from the grain growing area of Alberta and Saskatchewan to the Pacific coast and the Panama Canal, no other decision seemed possible. The Grain Commissioners voiced their disapproval of the city's laissez-faire attitude in not presenting a more elaborate case when the question was under consideration, but to Calgarians, the situation is so apparent that the organizations most particularly interested may be excused for thinking that everyone else ought to see it as plainly as they.

SOME THERMAL PROPERTIES OF CONCRETE.

By Charles L. Norton, Mem.Am.Soc.M.E.

A few of the results of a series of experiments carried on at the Massachusetts Institute of Technology, during the past four-and-a-half years, formed the subject of a paper read by Prof. Norton, at a meeting of the American Society of Mechanical Engineers, in Boston, on February 25th. The purpose of the research was a study of the physical properties of Portland cement concrete, which affect its value as a fire resistant material. The experiments had not been completed, but there was much of interest in what had been already ascertained.

It was proposed at the outset to make a study of the various physical properties of Portland cement concrete over as wide a range of temperatures as possible, and among the properties were the following:—

a Coefficient of linear expansion
b Diminution of mechanical strength after heating
c Specific heat.
d Coefficient of thermal conductivity

A comparison with other materials was also planned.

Coefficient of Linear Expansion—The measurements of the coefficient of linear expansion are now practically completed. The method adopted for the measurements of elongation caused by heating was the common so-called telescope method. The specimens in the shape of 6-in. or 10-in. cubes were slowly heated in a double gas muffle or an electric resistance furnace. The temperature of the furnace and of a number of points in the concrete was taken by means of platinum-rhodium couples. Near the furnace were mounted two telescopes, which could be sighted through holes in the furnace wall upon reference points on the surface of the block. At low temperatures an arc light and system of mirrors were used to furnish adequate illumination. One of the telescopes was provided with a micrometer eye-piece by means of which a movement of the reference mark of 0.0001 in. could be measured.

The values obtained at low temperatures agree very well with the commonly accepted value of 0.0000055 for the elongation per unit of length per deg. Fahr. Apparently, this value increases slightly up to 575 deg. Fahr. Above this point the coefficient becomes smaller; at 1,500 deg. Fahr. the coefficient becomes zero, and above this point, slightly negative.

Table 1 gives the average values for a large number of specimens:—

Table 1 Average Value of Specimens.

Temperature, Deg. Fahr.	in the Expression $l_t = l_o \ (1+\beta t)$
72 to 360	0.0000045 to 0.000060
72 to 750	0.0000050 to 0.000060
72 to 1090	0.0000045 to 0.000050
72 to 1600	0.0000035 to 0.000042

The blocks which have been heated to 1,500 deg., did not return to their original dimension on cooling, their permanent elongation being about 75 per cent. of their maximum elongation. There was no sensible permanent elongation resulting from a second heating.

All of the specimens tested for expansion were of stone concrete of the proportions 1 : 2 : 5. The stone was clean, the sand sharp, the cement of good quality, and every precaution was taken to secure a concrete of the first order. The specimens weighed on the average 150 lb. per cu. ft. A considerable number of tests demonstrated that the dimension which these small cubes took during a rise in temperature was dependent upon the temperature of the outside rather than the average temperature of the block.

The variation of this coefficient with the temperature is such as to make the difference between it and the coefficient for steel considerable at high temperatures. As has been well understood, the similarity of the coefficient is helpful in preserving the integrity of reinforced concrete structures at ordinary temperatures, but the divergence of the two coefficients at higher temperatures is not a serious matter in the reinforced structure when exposed to fire, since the metal reinforcement and the concrete surface are rarely at the same temperature.

There is a marked expansion increase up to about 700 deg. Fahr., followed by a slower rate, and at about 1,500 deg. Fahr. by marked shrinkage.

Comparison with Clay Brick and Silica Brick.

	Clay Brick	Silica Brick
Temperature Range, Deg. Fahr.	Coefficient of Expansion (β)	
0 to 900	0.0000038	0.000012
0 to 1600	0.0000031	0.000008
0 to 1900	0.0000023	0.000007

Some bricks and all concrete are liable to a permanent set of about 75 per cent. of their total elongation on heating to 1,500 deg. Fahr.

Diminution of Mechanical Strength after Heating—In order to study the effect of high temperatures upon the compressive strength of concrete several scores of 6-in. and 8-in. cubes were made and allowed to set for 90 days or slightly longer. These blocks were heated at different temperatures in a gas furnace similar to that used for the expansion experiments, for different lengths of time at various periods from the 90 days up to five years.

The cubes which were not heated showed an average compressive strength of 2,700 lb. per sq. in. when 90 days old; at the end of five years the compressive strength of the blocks had risen to an average value of 4,278 lb. per sq. in. When aged for 90 days in a damp place, exposed to fire at 900 deg. Fahr. for two hours, the compressive strength fell to 2,200 lb., or a loss of 15 per cent. Blocks five years old, dry, exposed to fire at 1,700 deg. Fahr. for two hours, gave values of 1,500 to 1,000 lb. per sq. in., a loss of 50 per cent. to 65 per cent.

The loss was much more marked in the case of the 6-in. than the 8-in. cubes. It is evident that the small cubes give far too great loss in strength on heating. Some cubes allowed to stand lost much by slacking; this action has been noted by Professor Woolson in earlier tests. It should be noted also that there was a considerably greater deformation under load of the heated blocks than of those not heated.

A large number of small beams were next made, some with and some without reinforcement; most of these were either 6 in. by 6 in. by 48 in. or 8 in. by 8 in. by 48 in. The specimens which were reinforced contained four ½-in. round steel rods situated near the corners equidistant from the two faces of the beam. In some the distance from the reinforcement to the face of the beam was 1 in. and in others 1½ in. A few beams had a 2-in. protection to the reinforcement.

Three beams for example, each 6 in. by 6 in. by 48 in., in which the reinforcing rods were 1 in. from the face of the beams, were broken by center load, the first beam not having been heated at all, the second heated for one hour in a fire that fused the surface of the concrete, and the third being similarly heated for two hours. The beam which was not heated broke under a load of 5,700 lb., the second, heated for

one hour, broke at 2,750 lb., while the third, heated for two hours, broke at 1,950 lb. This is a most remarkable showing under severe conditions. It should be borne in mind that these small beams were so slow in cooling down that they showed the effect of heating much longer than the time mentioned, say 24 hours. The flames, moreover, surrounded the beams on all sides. In tests at three and five year ages, the temperature was between 1,600 deg. and 1,700 deg. Fahr.; the 8 in. by 8 in. by 48 in. reinforced beams broke at 14,200 lb. when not heated, but at 4,920 lb. when heated. Smaller beams 6 in. by 6 in. by 48 in., not reinforced, broke at 1,300 lb. when not heated, at less than 100 lb. heated.

As a result of these tests upon the beams, it was evident that the failure of the specimens was in every case due to the rods pulling through the concrete. This is wholly a matter of insufficient anchorage, and these short beams are therefore not very helpful in giving information concerning the behavior of full-sized beams in buildings, and except as they give relative information concerning different mixtures, they are of very little value. The small cross-section of these beams tends to make the fire exposure abnormally high. It should be noted that all of the non-reinforced beams broke in handling, which suggests the severity of the tests as compared with the experience of actual conflagrations.

A series of similar beams was next made up of cinder concrete, the proportions of the mixture being 1 : 2 : 5. A portion of these were mixed with clean cinders, which showed upon analysis but little carbon; a second part was mixed with cinders to which 10 per cent. of fine bituminous coal had been added and the other beams were mixed with cinder, to which had been added 25 per cent. of fine coal. The 25 per cent. mixture can be disposed of in a word—when once thoroughly heated it burned until it fell to pieces. With the 10 per cent. mixture, however, no such action occurred; there was no indication that the concrete would support its own combustion even for a short time. It was apparent, however, that the 10 per cent. mixture was not so good a fire-resistive material as that which contained no added carbon. From the few specimens containing less than 10 per cent. which have been examined up to the present, it seems probable that the safe limit is close to 5 per cent. More information is now being secured on this point by the use of larger beams.

Specific Heat—The study of the specific heat of concrete was made by the ordinary calorimeter method, the "method of mixtures" of Regnault. Specimens of the concrete, usually fragments of the larger test pieces, were heated slowly in an electric resistance furnace to the desired temperature and then plunged into the calorimeter. The weight of the water and its rise in temperature give the amount of heat given off by the body in cooling. Extraordinary precautions were taken in getting the exact average temperature of the specimen in the furnace, and to insure its rapid transfer to the calorimeter. In most of the experiments a double calorimeter was used so that the specimen did not come in contact with the water of the calorimeter, so that any evolution of heat by hydration of the cement was avoided. Tables 2 and 3 give the specific heat of concrete and of other materials:—

Table 2—Specific Heat.

Temperature, Deg. Fahr.	Stone Concrete 1—2—5	Stone Concrete 1—2—4	Cinder Concrete 1—2—4
72 to 212	0.156	0.154	....
72 to 372	0.192	0.190	0.180
72 to 1172	0.201	0.210	0.206
72 to 1472	0.219	0.214	0.218

Table 3—Specific Heat of other Materials.

Material	Temperature	Specific Heat
Stone Concrete	72 to 500	0.210
Stone Concrete	72 to 800	0.204
Stone Concrete	72 to 212	0.180
Cinder Concrete	72 to 212	0.156
Red Brick	72 to 212	0.214
Red Brick	72 to 500	0.192
Red Brick	72 to 1100	0.200
Quartz	400 to 1200	0.308
		0.305
		0.279
Cement	room temperature	0.271
		0.186
Sand		0.191
Trap		0.201
	?	0.258
		0.270
Sandstone	?	0.220
Dolomites		0.222
Slag		0.169
Granite	?	0.173
		0.196
		0.200

Coefficient of Thermal Conductivity.—The measurements of thermal conductivity were made by a number of methods and have taken far more time and energy than all the others put together. The thermal conductivity is that property which determines how rapidly heat will travel through a substance and how rapidly therefore objects beyond will be heated by transmission. The conductivity becomes of prime importance in all questions of protection of the metal in reinforced concrete buildings. There is a limited amount of data to be found relative to this important property of any of the common materials of engineering and such data as are to be found are not concordant. As to the conductivity of concrete or its variation with temperature and with composition, practically nothing has been known.

The methods adopted for the measurements will be here described in outline only. The formula showing the relation of the temperature upon the two sides of a plate to the amount of heat which would flow through is as follows:—

$$Q = \frac{K\ (t_1 - t_2)\ sA}{d}$$

$$\text{or } K = \frac{Qd}{(t_1 - t_2)\ As}$$

where

K = the coefficient of thermal conductivity dependent upon the nature of the material and its temperature.

Q = the quantity of heat flowing through the plate in the area measured

A = the area

t_1 = the temperature of the hotter side of the plate

t_2 = the temperature of the cooler side of the plate

d = the thickness of the plate

s = time during which Q units flow through the area A.

The formula will be seen to be merely an expression of the following relations, that the flow of heat is proportional to the area, to the temperature and to the time, and that it is inversely proportional to the thickness.

After spending many months in attempting to develop other methods, the electrical method used by the writer for the past 15 years in studying the flow of heat through steam

pipe coverings was adopted. The value Q of the heat flowing was determined by supplying the heat by means of the heating of a conductor carrying a current of electricity; by measuring the electrical energy supplied the quantity of heat developed may be known with great precision. Further, if this heat is passed through the plate under test and into a calorimeter on the far side, a check upon the value of Q may be had. For the determination of the temperature difference, thermal couples, resistance thermometers, and mercury thermometers were used, but thermal junctions made of thin strips of copper and nickel, or of platinum and platinum-rhodium, were generally found most serviceable.

The apparatus used for the lower temperatures consisted of a thin, electrically-heated plate, to the two sides and edges of which concrete could be applied. Outside of the concrete there were then placed heavy copper or brass plates which could be kept at a constant temperature by an internal circulation of water. Thermal junctions were placed at several points on each surface and in the body of each concrete plate. The electrical input was measured by calibrated Weston instruments, and calibrated thermal junctions gave the value of the temperature difference to the nearest one-one hundredth of a degree. For the thickness, numerous measurements were made with a pair of flat-nosed calipers and averaged. It was necessary to keep this apparatus running for several days before it could be balanced, that is, before the rate of flow of heat outward through the plates became constant and equal to the electrical input.

Later, in order to make tests on plates as thick as some of the walls in common use, another method was adopted. Cubical boxes 36 in. in outside dimension were built with walls of several thicknesses. Inside the boxes were placed electric heaters which served to raise the inside surface to a temperature above that of the surroundings and a small fan served to keep the air in the box stirred to insure uniformity of temperature throughout. The boxes were tightly sealed. The power supplied to both heater and fan was measured as before. Mercury thermometers and thermal junctions, as well as a Callender recording resistance thermometer, were used to measure the difference in the temperatures inside and outside of the box.

Data have been secured on scores of specimens and they are practically identical with the results obtained by the plate tester. It must be borne in mind that the thermal conductivity is based upon the difference in temperature at some two points in the material itself and not the difference in the temperature of the air on the two sides of the specimen. If, for instance, a 6-in. wall of solid stone concrete separates two spaces whose temperatures are 40 deg. Fahr. apart, the surface temperatures of the concrete will be much nearer one another than 40 deg. Fahr. There is a drop in temperature in passing through the wall which is dependent upon the thermal conductivity and upon the quantity of heat passing through. There is a drop in temperature at the surface which is dependent on a rather complex set of relations between the temperature and nature of the surface and the surroundings and the adjacent air. For many materials the amount of heat lost from a surface for small differences in temperature not over 20 deg. Fahr. is between 16 and 18 B.t.u. per sq. ft. per 24 hours for 1 deg. difference between the surface and the average temperature of the surroundings. More than one-half of this is a loss by radiation in accordance with the Stephan-Boltzman law.

$$\text{Energy} = \text{Constant}\ (T^4 - T_0^4)$$

$$W = 5.7\ E\left[\left(\frac{T}{1000}\right)^4 - \left(\frac{T_0}{1000}\right)^4\right]$$

where

W = watts

T = absolute temperature of surface

T_0 = absolute temperature of surrounding.

E = about 0.6 to 0.7 (always less than 1)

For the high temperatures a modification of the entire process was found necessary. The concrete to be tested was cast in the form of a cylinder on the outer surface of and concentric with a steel bar which could be heated to a high temperature by the passage of a heavy current. Outside of the cylinder of concrete was applied a closely fitting "continuous" calorimeter. The temperatures of the bar and of the calorimeter were measured by thermal junctions, and the amount of water and its rise in temperature gave the value of Q. In order to guard against the uncertainty of the temperature at the ends of the bar, the calorimeter was made so as to enclose only about one-half the length of the bar, the rest being covered by guard rings similar to the calorimeter, but without provision for the measurement of the quantity of water.

The heating of the bars required a considerable amount of special apparatus, since it was necessary to provide a current of upwards of 2,000 amperes for the high temperatures, and to be able to vary its amount to any desired value below that point. For this purpose there were installed three 15-kw. transformers connected on the primary side with a three-phase 2,300-volt circuit. By means of divided secondaries and a rather elaborate arrangement of switches, the secondary voltage could be varied from 190 volts down to 55 volts. This secondary voltage was applied to the primary of a second step-down transformer, whose secondary was divided into 20 coils. By means of a switchboard the entire output of the transformer could be had at almost any desired low voltage. This enabled us to heat bars insulated by materials of different composition and of different thicknesses to any desired temperature up to 2,800 deg. Fahr. With this arrangement both the steel and the concrete can be easily melted.

The results obtained are given in Table 4. It is to be regretted that there is no uniformity of practice as to the units to be adopted in reporting the measure of effectiveness of insulators. While the physicist renders his report in calories per square centimeter, per centimeter thickness, per one degree centigrade per second, the steam engineer confines his observations to B.t.u. per hour, per square foot, per inch of thickness, per one degree Fahrenheit, and the refrigerating engineer reports on the basis of a 24-hour time unit. The

Table 4—Coefficient of Thermal Conductivity of Concrete.

Temperature of Hot Side of Plate Deg. Cent.	Deg. Fahr.	Mixture	Coefficient, Cal. per 1° C. per sq. cm. per cm. per sec.	Coefficient, B.t.u. per 1° F. per sq. ft. per in. thick per 24 hours
35	95	Stone 1—2—5	0.00216	150.
50	122	Stone 1—2—4 not tamped	0.00110 to .00160	76. to 114.
50	122	Cinder 1—2—4	0.00081	56.
200	392	Stone 1—2—4	0.0021	146.
400	752	Stone 1—2—4	0.0022	153.
500	932	Stone 1—2—4	0.0023	160.
1000	1832	Stone 1—2—4	0.0027	188.
1100	2012	Stone 1—2—4	0.0029	202.

writer has even seen a report in terms of hogsheads of water raised to the boiling point, time not stated. A brief comparison of these values with those for other materials may be interesting.

The specific heat of concrete is slightly less than that of either red brick or fire brick, hence the amount of heat needed to raise the temperature of a pound of brick is about 10 per cent. more than for a pound of concrete. But the density of concrete is enough greater than that of brick to raise

the heat capacity of a cubic foot of concrete above that of brick. The difference is not large, however,

It seems clear that for a time after the beginning of exposure to fire, the concrete and its reinforcement will expand at much the same rate, but that the further expansion of the surface will not proceed at so rapid a rate. This will tend to reduce the stresses which the expansion of the heated surface would otherwise set up in the cooler interior. It is perhaps because of the failure of the concrete to return to its original dimensions that the small amount of surface cracking found after a fire is due.

The experiments made with coal and cinder mixtures indicate the necessity of added care in the selection of cinders for this purpose.

Table 4 of thermal conductivities gives data as to the rate at which heat will travel through concrete. It is interesting to note the great difference between the tamped and the untamped concretes made from stone. The one was as porous as possible, and the other as dense. One transmits nearly twice as much heat as the other. The cinder concrete, as is commonly believed, is much better as a heat insulator than the stone concrete, being nearly three times as effective as the denser stone concrete in retarding the flow of heat. It may be interesting to call attention to the heat insulation afforded by other materials. The best of the commercial articles commonly used for this purpose is compressed cork, which is nearly 25 times as effective as stone concrete. Steel on the other hand, transmits heat from 75 to 100 times as fast as the densest of the stone concrete.

Table 5—Thermal Conductivities..

Material	B.t.u. per 24 Hours per 1 Deg. Fahr. Sq. Ft. per 1 In. Thick.
Agglomerated Cork	6.4 to 9.0
Linings or Quilts of Hair and Flax	10.0 to 18.0
Pine	13.0
Oak	26.0
Spruce	14.0 to 18.0
Magnesia	10.0
Asbestos Sponge	8.0

STEEL BRIDGE PROTECTED WITH CEMENT.

The Department of Public Works in Pittsburg has recently made use of an ingenious method to save from deterioration a footbridge on Pine Street that passes over the railroad tracks. This steel frame was becoming affected by the gases from the engines that passed beneath it. In order to save the bridge from ruin the board enclosed it in concrete, which was so attractively and effectively set in place that the bridge is now stronger and far more artistic than ever, and at the same time is protected from any further attacks by the deleterious fumes. The entire structure, including the stairways, the supports, the floor and railing, were covered with a layer of cement, and the viaduct is now a reinforced concrete structure, although such a thing was not contemplated at the time of its erection. The idea is so practical that it may be worth following elsewhere in the case of metal structures of various kinds that are subjected to disintegrating gases.

Escher Wyss & Company have moved their head Canadian office from the Canadian Express Building to the Coristine Building, Montreal.

HIGHWAY CONSTRUCTION WITH PAINT BINDER AND ITS SHEET ASPHALT SURFACE.

A type of construction not generally used in the building of interurban roads is being employed on one of the roads of the state highway system of California on the section lying between South San Francisco and Burlingame. The most unusual features of the construction are the thin asphalted binder coat, and the 1-in. sheet asphalt surface. The following description of the work on this section is abstracted from an article by Mr. A. E. Loder, division engineer, in the California Highway Bulletin, the official publication of the State Highway Commission:

The roadway is graded to a width of 40 ft., with a maximum gradient of 4 per cent. conforming with the rolling contour of the country. Long, easy, vertical curves connect all changes of grade, producing a pleasing profile. Flat curves are used at every deflection in the line.

The pavement is 24 ft. in width and has a crown of 4 ins. Earth shoulders containing gravel and old macadam extend to a width of 8 ft. along each side of the pavement with a cross slope of 1¼ ins. per foot. The pavement rests upon a thoroughly compacted sub-grade composed of old macadam and a sand-clay mixture resembling hardpan, which after rolling is in such condition that it is not damaged when the gravel and sand are hauled and dumped directly upon it without the use of planking, and it remains so compact that no dirt is picked up with the sand when loading it into the mixer.

Timber headers 2 ins. by 6 ins., nailed to stakes, line the pavement trench and are laid to a line flush with the finished surface. These protect the edges of the pavement while the shoulders are being settled by traffic, and provide a means by which the pavement may be readily brought to a true and uniform surface.

The pavement consists of a 5-in. concrete base composed of a 1:3:6 mixture, to which is bounded a standard sheet asphalt surface 1 in. in thickness.

The concrete is prepared in a portable mixer to a rather wet consistency and is delivered directly to its place in the pavement by means of a swinging spout. The surface is given a rough finish, suitable for binding bituminous materials, by sweeping across the line of pavement with a stiff house broom or warehouse broom before the concrete reaches its final set. The new concrete is watered daily, except in rainy or damp, cloudy weather, until about five days old.

The asphalt wearing surface being laid on this job is shown on the daily test sheets to be as near the standard grading and composition as is possible to obtain. Nothing unusual is noted in connection with its use, except that a greater density is obtained after rolling the one-inch sheet than is possible with a thicker city surface, and consequently better wearing qualities and more stability should be expected.

When the concrete is dry and at least one week old, it is thoroughly swept, removing the dust of traffic passing at the side of the road. The binder coat is then applied. This coat consists of 1 part by volume of melted asphaltic cement, of the consistency used in the pavement, to 2 parts by volume of engine distillate. The asphaltic cement is heated in a small portable kettle to a temperature between 200° and 325°. A measured quantity is removed to the spreading pail a safe distance from the fire and allowed to cool to about 250°. The distillate is then added and stirred for about one minute, when it is found to be thoroughly uniform and the temperature is reduced by at least 100°. The distillate can be added when the asphalt is at a temperature of 325°, but at this tem-

perature it is accompanied by considerable boiling and is somewhat dangerous.

The binder liquor, while hot, is poured over the concrete from buckets, and uniformly swept over the surface with stiff house brooms until every particle of surface is coated with a thin film and all excess is swept from holes or depressions in the concrete. The paint binder penetrates deeper into the concrete when permitted to flow in a thin wave ahead of the first sweeping. A second sweeping after a few minutes removes excess from depressions and spreads it uniformly over the concrete. The thinnest possible application of paint should be used so that after evaporation, which is completed in from one and one-half to two hours, the surface should have a glossy black appearance. If too small a quantity is used, or if the percentage of asphaltic cement to distillate is considerable less than above, a brown surface will result, which will not make a successful bond with the asphalt surface.

Two men can easily mix and apply this asphaltic coat on 12,000 sq. ft. per day. On 69,000 sq. ft., where the proportions were being varied somewhat, it was found that 100 sq. ft. required 0.856 gal. of engine distillate and 3.5 lb. of asphaltic cement. The total cost on above area, including 15 per cent. on labor, was $0.0018 per square foot of surface.

It is found that no inconvenience is caused to the work of laying asphalt by the placing of the asphaltic coat. After one hour's time it does not stick to the wheels of motor trucks or wagons. It is not desirable to so cover the concrete farther ahead of the asphalt work than is required for the distillate to evaporate and leave the binder hard.

In one case, several days' rain which fell on paint freshly applied caused the asphaltic coat to appear loosened from the concrete in many places. After two days' dry weather, however, it seemed to bond again to the concrete so that it could not be removed. It is believed that the paint binder will tend to waterproof the asphalt surface, preventing damage to its under side from moisture which may rise through the concrete.

If the asphaltic coat is allowed to accumulate in any quantity in a depression such as a heel mark, its location is soon apparent after the placing of asphalt since excess asphaltic cement appears on the surface during rolling. With reasonable sweeping, however, no trouble of this kind has been experienced.

There is a marked difference in the behavior of hot asphaltic mixture under the roller where the paint binder has been used and where it has been omitted. Where concrete has been painted, the asphalt does not move or welt up in front of the roller to any appreciable extent, as is noted when rolling asphalt on plain concrete.

It is found that the asphaltic cement, while dissolved in the distillate, penetrates into the surface of the concrete to a distance of from 1/10 in. to ⅛ in. and in some cases even further. Samples of the surface removed show the concrete adhering uniformly to the asphaltic surface. When removing the sample the concrete is fractured and a layer of solid concrete is removed, carrying the first layer of finer gravel. When trimming a joint to begin a new day's work, the surface of the concrete base is always broken off in removing the thin edge of asphalt which has been cut from the finished work.

For experimental purposes, a few hundred feet of the surface has been placed without the use of the paint binder. As expected, no bond is secured except that of a mechanical nature, due to the roughness of the concrete. Notwithstanding this, the surface remains in first-class condition after one month of heavy traffic, and it is believed that good results will be obtained under wear without the use of a binder of any kind. However, the use of this binder at so small an additional cost will improve the pavement and prolong its life to such an extent it will more than justify its expense.

MAY FIRE LOSSES

The Canadian Engineer's estimate of Canada's fire loss during May amounted to $2,123,868, compared with April loss of $1,470,622 and $2,251,815 for the corresponding period of last year. The following is the estimate for May losses:—

Fires exceeding $10,000	$1,540,500
Small fires	306,342
Estimates for unreported fires	277,026
	$2,123,868

The following are the monthly totals of the losses by fire during 1910, 1911, 1912, and 1913:—

	1910.	1911.	1912.	1913.
January	$ 1,275,246	$ 2,250,550	$ 3,002,650	$ 3,913,385
February	750,625	941,045	1,640,153	2,037,386
March	1,076,253	852,380	2,261,414	1,710,756
April	1,717,237	1,317,900	1,355,055	1,470,622
May	2,735,536	2,564,500	2,251,815	2,123,868
June	1,500,000	1,151,150	4,229,412	....
July	6,386,674	5,384,300	1,741,371	....
August	1,667,270	920,000	1,164,760	....
September	894,125	1,123,550	883,949	....
October	2,195,781	580,750	1,416,218	....
November	1,943,708	1,506,500	1,184,010	....
December	1,444,860	2,866,950	1,769,905	....
	$23,593,315	$21,459,575	$22,900,712	$11,256,017

During May thirty-three lost their lives through fire; this is the largest number of fatalities since July, 1911.

The following are the monthly totals compared with 1909, 1910, 1911 and 1912:—

	1909.	1910.	1911.	1912.	1913.
January	16	27	27	27	14
February	8	15	12	11	21
March	16	20	18	24	22
April	18	37	20	15	11
May	21	15	28	18	33
June	16	52	13	6	..
July	4	15	110	9	..
August	17	11	22	16	..
September	10	10	13	6	..
October	26	16	17	21	..
November	34	19	20	22	..
December	33	19	17	28	..
Totals	219	256	317	203	101

The fire waste in each province for first five months of this year has been estimated by *The Canadian Engineer* as follows:—

Ontario	$2,697,806
Alberta	2,649,203
Manitoba	1,542,912
Quebec	1,109,266
Nova Scotia	943,409
New Brunswick	730,801
Saskatchewan	717,295
British Columbia	490,538
Prince Edward Island	374,787
	$11,256,017

COMPARATIVE STATEMENT OF CANADA'S MINERAL PRODUCTION

FOR YEARS 1910 AND 1911

Product.		1910			1911			Increase (+) or Decrease (−).		Increase (+) or Decrease (−).	
		Quantity.	Value (a)	Per cent of total.	Quantity	Value (a)	Per cent of total.	Quantity.	%	Value.	%
Metallic			$	%		$	%			$	
Antimony ore	*Tons	364	13,906		0	0				− 13,906	
Cobalt (i)	Lbs.		51,986							− 51,986	
Cobalt oxide and nickel oxide	"				154,174	221,690	0.22			+ 221,690	
Cobalt material, mixed cobalt and nickel oxides	"				1,260,832						
Copper (b)	"	55,692,369	7,094,094	6.64	55,648,011	6,886,998	6.67	− 44,358	0.08	− 207,096	2.92
Gold	Ozs.	493,707	10,205,835	9.55	473,159	9,781,077	9.48	− 20,548	4.16	− 424,758	4.16
Pig iron from Canadian ore (c)	Tons	104,906	1,650,849	1.54	42 186	613,404	0.59	− 62,720	59.79	− 1,037,445	62.84
Iron ore sold for export (k)	"	114,449	324,186	0.30	40,137	88,570	0.09	− 74,312	64.95	− 235,616	72.68
Lead (a)	Lbs.	32,987,508	1,216,249	1.13	23,784,969	827,717	0.80	− 9,202,539	27.90	− 388,532	31.95
Nickel (e)	"	37,271,033	11,181,310	10.46	34,098,744	10,229,623	9.91	− 3,172,289	8.51	− 951,687	8.51
Silver (f)	Ozs.	32,869,264	17,580,455	16.45	32,559,044	17,355,272	16.81	− 310,220	0.94	− 225,183	1.28
Zinc ore	Tons	5,063	120,003	0.11	2,590	101,072	0.10	− 2,473	48.84	− 18,931	15.78
Total			49,438,873	46.28		46,105,423	44.67			− 3,333,450	6.74
Non-Metallic.											
Actinolite	Tons	30	330		67	736		+ 37	123.00	+ 406	123.00
Arsenious oxide	"	(j) 2,049	(j) 81,044		2,097	76,237		+ 48	2.34	− 4,807	5.93
Asbestos	"	77,508	2,555,974	2 39	101,393	2,922,062	2.83	+ 23,885	30.82	+ 366,088	14.32
Asbestic	"	24,707	17,629		26,021	21,046		+ 1,314	5.32	+ 3,417	19 38
Chromite	"	299	3,734		157	2,587		− 142	47.49	− 1,147	30.72
Coal	"	12,909,152	30,909,779	28.93	11,323,388	26,467,646	25.64	− 1,585,764	12.28	− 4,442,133	13.50
Corundum	"	1,870	198,680	0.18	1,472	161,873	0.15	− 398	21.28	− 36,807	18.53
Feldspar	"	15,809	47,667		17,723	51,939		+ 1,914	12.11	+ 4,272	8.96
Fluorspar	"	2	15		34	238		+ 32		+ 223	
Graphite	"	1,392	74,087		1,269	69,576		− 123	8.84	− 4,511	6.09
" artificial	"	1,221			1,086			− 135	11.06		
Grindstones	"	3,973	47,196		4,566	52,942		+ 593	14.92	+ 5,746	12.17
Gypsum	"	525,246	934,446	0 87	518,383	993,394	0.96	− 6,863	1.31	+ 58,948	6.31
Magnesite	"	323	2,160		991	5,531		+ 668	206.00	+ 3,371	156.00
Manganese	"				5½	300		+ 5½		+ 300	
Mica			190,385	0 17		128,677	0.12			− 61,708	32.41
Mineral Pigments—											
Barytes	Tons	0	0		50	400		+ 50		+ 400	
Ochres	"	4,813	33,185		3,622	28,333		− 1,191	24.75	− 4,852	14.62
Mineral Water			199,563	0.18		223,758	0.21			+ 24,195	12.12
Natural Gas (g)			1,346,471	1.26		1,917,678	1.85			+ 571,207	42.42
Peat	Tons	841	2,604		1,463	3,817		+ 622	73.96	+ 1,213	46.58
Petroleum (h)	Bls.	315,895	388,550	0.36	291,092	357,073	0.34	− 24,803	7.85	− 31,477	8.10
Phosphate	Tons	1,478	12,578		621	5,206		− 857	57.98	− 7,372	58.61
Pyrites	"	53,870	187,064	0.17	82,666	365,820	0 35	+ 28,796	53.45	+ 178,756	95.56
Quartz	"	88,205	91,951		60,526	83,865		− 27,679	31.38	− 8,086	8.79
Salt	"	84,092	409,624	0.38	91,582	443,004	0.42	+ 7,490	8.91	+ 33,380	8.15
Talc	"	7,112	22,308		7,300	22,100		+ 188	2 64	− 208	0.93
Tripolite	"	22	134		20	122		− 2	9.09	− 12	8.96
Total			37,757,158	35.34		34,405,960	33.33			− 3,351,198	8.88
Structural Materials and Clay Products.											
Cement, Portland	Bls.	4,753,975	6,412,215	6.00	5,692,915	7,644,537	7.41	+ 938,940	19.75	+ 1,232,322	19.22
Clay products—											
Brick, common	No.	627,715,319	5,105,354	4.77	645,550,517	5,420,890	5.25	+ 17,835,198	2.84	+ 315,536	6.18
Brick, pressed	"	67,895,034	807,294	0.75	87,350,539	1,094,582	1.06	+ 19,455,505	28.65	+ 287,288	35.59
Brick, paving	"	4,214,917	78,980		5,220,400	79,444		+ 1,005,483	23.86	+ 464	0.59
Brick, moulded & ornamental		703,345	16,092		605,643	11,281		− 97,702	13.89	− 4,811	29.89
Fireclay and fireclay products			50,215			89,130				+ 38,915	77.50
Fireproofing and architectural terra-cotta			176,979	0.16		409,585	0.39			+ 232,606	131.00
Pottery			250,924	0.23		102,493	0 10			− 148,431	59.15
Sewer-pipe			774,110	0.72		812,716	0.79			+ 38,606	4.99
Tile, drain	No	24,562,648	370,008	0 34		339,812	0.32			− 30,196	8.16
Lime	Bus.	5,848,146	1,137,079	1.06	7,533,525	1,517,599	1.47	+ 1,685,379	28.82	+ 380,520	33.46
Sand-lime brick	No.	44,593,541	371,857	0.34	51,535,243	442,427	0.43	+ 6,941,702	15.57	+ 70,570	18.98
Sand and Gravel (exports)	Tons	624,824	407,974	0.38	573,494	408,110	0.39	− 51,330	8.22	+ 136	0.03
Slate	Squares	3,959	18,492		1,833	8,248		− 2,126	53.70	− 10,244	55.39
Stone—											
Granite			739,516	0 69		1,119,865	1.08			+ 380,349	51.43
Limestone			2,249,576	2.10		2,594,926	2.51			+ 345,350	15.35
Marble			158,779	0.14		162,783	0.15			+ 4,004	2.52
Sandstone			502,148	0.47		451,183	0.43			− 50,965	10.15
Total			19,627,592	18.37		22,709,611	22.00			+ 3,082,019	13 57
Grand Total			106,823,623	100.00		103,220,994	100.00			− 3,602,629	3.37

CANADA'S MINERAL PRODUCTION.

The table on the opposite page is from the current issue of *The Monetary Times*. With the following explanation of symbols used, it should be of great value to all readers of *The Canadian Engineer*:—

*Short tons throughout. (*a*) The metals copper, lead, nickel, and silver are for statistical and comparative purposes valued at the final average value of the refined metal. Pig iron, zinc ore, and cobalt oxides are valued at the furnace or spot, and non-metallic products at the mine or point of shipment. (*b*) Copper content of smelter products and estimated recoveries from ores exported, at 12.376 cents per pound, in 1911; and 12.738 cents per pound in 1910. (*c*) The total production of pig iron in Canada in 1911 was 917,535 tons valued at $12,307,125, of which it is estimated 875,349 tons valued at $11,693,721 should be credited to imported ores; in 1910, the total production was 800,797 tons valued at $11,245,622, of which 695,891 tons valued at $9,594,773 are credited to imported ores. (*d*) Refined lead and lead contained in base bullion exported at 3.480 cents per pound, in 1911; and 3.687 cents in 1910, the average prices in Montreal and Toronto respectively. (*e*) Nickel content of matte produced value at 30 cents in 1910 and 1911. (Increasing quantities of nickel-copper matte are now being used in making monel metal which is sold at a price much below that of refined nickel.) The value of nickel contained in matte, as returned by the operators, was about 10 cents per pound for both years. (*f*) Estimated recoverable silver at 53.304 cents per ounce in 1911, and at 53.486 cents in 1910. (*g*) Gross returns for sale of gas. (*h*) Quantity on which bounty was paid and valued at $1.22½ per barrel in 1911 and at $1.23 in 1910. (*i*) Value received in 1910 by shippers of silver cobalt ores for cobalt content. Cobalt not paid for in 1911. (*j*) In 1910 includes 547 tons arsenical ore valued at $5,716. (*k*) In 1911, figures as reported by the producers, which differ slightly from those of the Trade and Navigation reports.

FITCHBURG SEWAGE DISPOSAL PLANT.

Points in the Design of Siphon and Grit Chambers of Main Interceptor—Settling Tanks and Sprinkling Filters are Also Special Features

In the fifth semi-annual report of the Sewage Disposal Commission for the city for Fitchburg, Mass., two interesting structural features of the main interceptor belonging to the new system were described. These are respectively the siphon and grit chambers. It will be remembered from previous articles that the commission was created in 1910 with authority to construct a main trunk sewer and a system of sewage disposal that would meet with the approval of the Massachusetts State Board of Health. The commission has Mr. David A. Hartwell as chief engineer and Mr. Harrison P. Eddy as consulting engineer.

Siphon Chamber.—The first section of the main interceptor is 5,989 ft. long. Of this distance 5,070 ft. is 30-in. cast iron pipe and 919 ft. is 48-in. concrete sewer. At the junction of the 48-in. sewer with the 30-in. cast iron pipe there has been constructed a siphon chamber, so arranged that when the flow in the sewer exceeds the capacity of the 30-in. siphon the excess will spill to the river through a 24-in. pipe line. The capacity of the 30-in. siphon is about 11,000,000 gals. per day, and as the present flow of sewage is only about one-half this amount it is only at times of considerable rain that anything from the sewer will flow through this overflow pipe to the river. The siphon is also

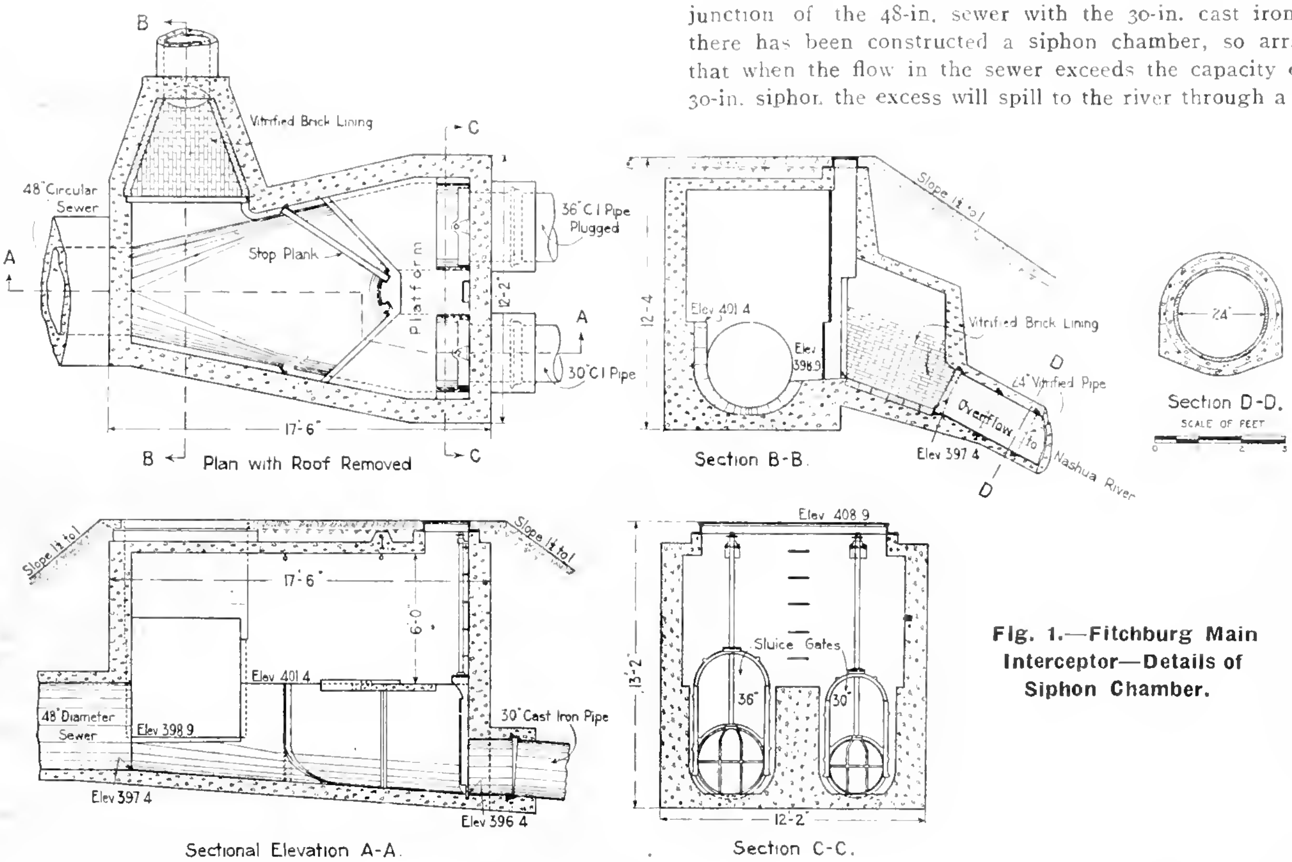
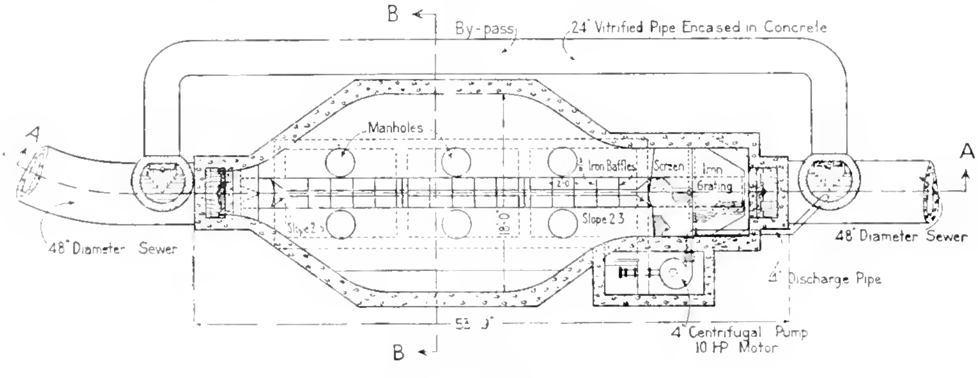


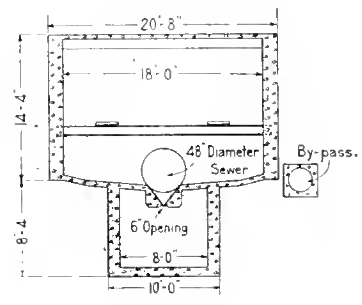
Fig. 1.—Fitchburg Main Interceptor—Details of Siphon Chamber.

constructed with a 36-in. connection for an additional siphon pipe to be laid when the normal flow of sewage about equals the capacity of the 30-in. pipe. This overflow can be regulated by stop planks so that when the 36-in. pipe line is also laid no flow will be diverted to the river unless the amount flowing in the 48-in. sewer should exceed the capacity of both pipe lines. This siphon has a hydraulic grade of 1 ft. in 350 ft. When this 30-in. pipe is carrying the present amount of sewage the velocity of flow will be about 1½ ft. per sec., which would probably prevent the pipe from clogging if there were no gravel or sand carried with the sewage. To avoid possible clogging at time of storm a grit chamber has been constructed about 1,400 ft. above the siphon chamber, and between which and the siphon chamber there are no lateral connections. This grit chamber will be described in detail later. In case this siphon should become partially clogged provision has been made for blowing out the line by placing a 30-in. gate and blow-off pipe at the crossing of the river on land taken for the disposal area. This gate is so located and the siphon so laid that it will be completely and rapidly emptied when the blow-off gate is opened. The siphon chamber complete, as shown in Fig. 1, was built at a contract cost of $500.

Grit Chamber.—In all combined sewer systems there is at times of heavy rain considerable sand and gravel washed from the streets into the sewers. The catch-basins retain large quantities of this material but the rapidity of the flow through the catch-basins at times of heavy rains is such as to carry large quantities of mineral matter into the sewers. Before the sewage is treated in tanks at any disposal plant it is advisable to remove as much as possible of this mineral matter. This is done by grit chambers which are usually located near the disposal plant. Owing to the location of the long inverted siphon in the Fitchburg intercepting sewer with the lower end at the disposal plant it seemed desirable to construct the grit chamber above this siphon. Theoretically, the best location would be directly above the siphon chamber, but it seemed undesirable to build such a structure on private land if any other satisfactory location could be found. The location determined upon for this structure was in the sewer department yard about 1,400 ft. from the siphon chamber. While this grit chamber is located some distance from the siphon chamber still there will be no lateral connections with the sewer between the two. The general details of this grit chamber are shown in Fig. 2. The total length is 53 ft. 9 ins. and the maximum inside width is 18 ft. The sump or grit catcher situated below the sewer invert is 31 ft. 6 ins. long, 8 ft. wide and about 7 ft. deep. At the lower end of the sump is a pump well with a 4-in. centrifugal pump vertically connected with an electric motor with which to remove the water from the sump when it is desired to remove the sand and gravel settled from the sewage. The material collected in the sump will be removed in buckets through manholes provided in the floor and roof of the chamber. There is a 6-in. opening in the line of the sewer invert through the grit chamber floor the full length of the sump. Spaced 2 ft. apart there are placed in this opening iron baffle plates, the tops of which are of the same shape and at the grade of the sewer invert. These baffles are designed to arrest the flow of any mineral matter beginning to settle and divert it into the sump. The floor of the grit chamber was designed both in plan and section so that the velocity of the flow would be about 1 ft. per sec., no matter what volume was flowing in the 48-in. sewer. The table gives data relative

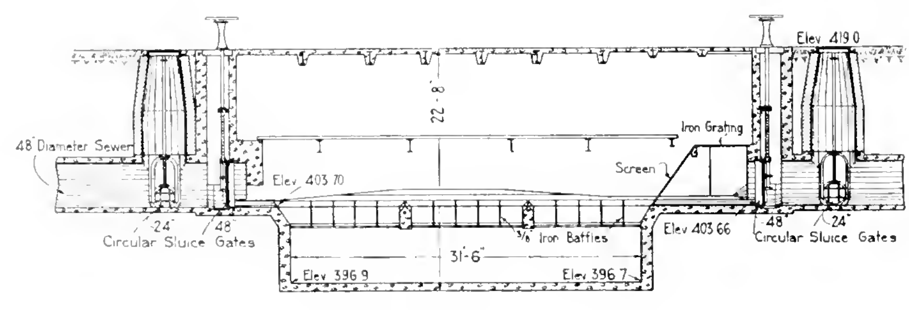


Plan with Roof Removed



Section B-B

Fig. 2.—Fitchburg Main Interceptor —Details of Grit Chamber.



Sectional Elevation A-A.

Flow and Velocities in Interceptor and Grit Chamber.

Flow	Gals. per day	Cu. Ft. Sec.	Depth in 4-ft. sewer.	Velocity in 4-ft. sewer.	Area of maximum water section in Grit Chamber.	Velocity in Grit Chamber.
1910 Minimum,	3,000,000	4.65	.92	2.06	3.99	1.17
1910 Average,	4,000,000	6.20	1.08	2.24	6.27	.99
1910 Maximum,	6,000,000	9.30	1.32	2.53	9.97	.93
1910 Storm	10,000,000	15.50	1.70	2.91	16.68	.93
1940 Average,	6,875,000	10.65	1.40	2.64	11.32	.94

Capacity of 4-ft. sewer with grade of .001 = 39.38 c. f. s.
Velocity of 4-ft. sewer with grade of .001 = 3.13 f.t per sec.
All above computations with n = .015 in Kutter's formula.

to velocities in the main sewer and grit chamber for the probable flow under conditions immediately following the completion of the present construction and also for the average flow of domestic sewage in 1940.

At the lower end of the grit chamber there is placed a screen so that any large matters in the sewage will be removed. This screen is made of 2-in. by ⅜-in. flat bars spaced 2 ins. apart on centres, making an opening between bars of 1⅝ ins. A 48-in. sluice gate is placed at each end of the grit chamber and a 24-in. by-pass constructed so that at times of removing grit from the sump the sewage will be carried around the chamber. This diverting of the sewage around the chamber will be only at such times as there is no storm water with the sewage. The grit chamber is roofed over at the surface of the ground with a concrete slab reinforced with I-beams and wire mesh. A small brick building for housing the electric motor and other equipment will be erected the coming season. This grit chamber was constructed by the International Construction Company, of Boston, at a total cost to the city of about $8,000.

The plans for the disposal plant have reached completion and bids were opened recently for the construction of settling tanks with separate sludge digestion chamber trickling filters, secondary settling tanks, etc.

Settling Tanks.—Sewage delivered to the works by the 30-in. cast iron siphon is first passed through a 30 x 15-in. recording Venturi meter and is then conducted to the battery of five Imhoff settling tanks. These tanks are built side by side and each is 90 ft. long, 30 ft. wide and has a maximum depth of 26 ft. As regards the inlet and effluent connections, both ends of each tank are identical in design, so that the direction of flow of sewage may be reversed periodically to equalize the sludge deposition on the tank bottom. The inlet to each tank consists of three 12-in. openings below the flow line, controlled by hand-operated sluice gates. The tanks are designed to afford a storage period of three hours, and the sludge-digesting compartment is sufficient for six months' accumulation. Under each gas vent is a sump for the collection of the sludge. Air pumps are to be used in its removal and the deposit will then be conveyed directly to the drying beds, while the settled sewage will leave the tanks over weir plates protected by scum boards, and will flow by gravity to the sprinkling filter.

The sprinkling filter, 2 acres in area, is in the form of a rectangle 410 ft. long and 228 ft. wide. The filtering material will consist of a 10-ft. depth of stone, crushed to a size of from 1 to 2 in. At one end of the bed is a main 36-in. cast-iron header to which 16-in. lateral distributing pipes are connected at intervals of a little less than 13 ft. Each lateral line is controlled by a valve, so that the area of the bed to be dosed with sewage can be varied to suit operating conditions. These lateral lines are reduced from 16 to 12 in. in diameter about half way down the length of the bed. The lateral distributors are supported directly upon the filter stones, in which they are buried to a depth which will bring the top of the pipe about on a level with the surface of the filter beds. This design of the distribution system, therefore, eliminates the use of vertical risers, which are required when the distributors are laid along the floor of the filter beds.

After the joints in the cast-iron pipe distributors have been made with jute packing and lead the pipes are to be tapped with a 2½-in. hole and threaded to receive the distributor nozzles. The specifications lay stress upon the care which must be taken to drill and tap these holes so that the nozzles when inserted shall have their vertical axes exactly plumb. The nozzles will be spaced on 15-ft. centres along the distributor pipes and will throw a circular spray. The type of nozzle to be used has not yet been selected.

Secondary Settling Tanks.—The sprinkling filter effluent will be delivered by a 30-in. concrete conduit into four secondary settling tanks, designed to intercept any solid matter which may be washed out of the sprinkling filters. These secondary tanks are circular in plan, 30 ft. in diameter, 24 ft. deep, with hopper-shaped bottoms. The inlet to each tank is in the form of a cylindrical shell of ¼-in. boiler plate, to which is connected a 15-in. spiral riveted pipe. This inlet cylinder is open at both ends and serves to collect any floating matter which may be carried down to the tank. The effluent will pass over weirs into circular channels around the tops of the tanks and will flow down stepped inclines to an open concrete-lined channel leading to the north branch of the Nashua River. The sludge from these tanks will be removed by a motor-driven centrifugal pump and discharged into the sewage entering the Imhoff tanks, in which it will settle and be further digested with the suspended matters of the sewage. By this procedure it is hoped that the offensive and slowly drying secondary tank sludge can be successfully dried.

Sludge from the Imhoff tanks and from the secondary settling tanks will be dried upon a bed of sand composed of grains having an effective size of at least 0.15 mm. and a uniformity coefficient not exceeding 10. The porous character of the underlying material made it unnecessary to install any system of underdrainage. The bed will be separated into long strips, 15 ft. wide, by concrete posts and planks, and along the centre of each strip will be laid a narrow-gauge railway track to carry cars, into which the dried sludge will be shovelled and carried away.

The works are designed for a capacity of sewage equivalent to 100 gals. per capita per day, which is approximately the amount of water consumed, the tanks providing for an estimated population of 55,000 in 1925. It is expected that the entire plant will be ready for the treatment of sewage early in 1914.

PRINCIPLES OF SHOP DESIGN.*

The laying out of machine shops must depend on the area, the shape of the ground available, and the nature of the product manufactured by a firm. The aim should always be to avoid handling materials and products more than is absolutely essential. To this end certain relations of shops to each other, and to railway sidings or canals, will have to be observed, in addition to the internal designs of the shops, the placing of heavy and light machines therein, and the systems of industrial railways and dispositions of hoisting machinery; so that the main problem includes much detail that varies with the requirements of different classes of manufacture.

With respect to the relative positions of shops as affecting the handling of work, two general cases arise. One is that of concentration in a few buildings, the other their isolation in separate buildings. In a large degree the choice between these depends on the size of a concern. The larger it is, the more desirable does the isolation of shops and of departments in shops become, partly because the necessities of supervision, partly of those of higher specialization. A small firm can carry on its machining and assembling work all under one roof, in charge of one foreman. A very large works must not only separate these departments, but must also create sub-departments in each, for light and for heavy work at least; and very often further sections must be ar-

*Condensed from The Times (London) Engineering Supplement.

ranged according to the class of machine used, as planers, drills, gear cutters, grinders, and so on. Then the question arises whether all these shall be included in one large shop covered by one roof, or be housed in separate buildings or on distinct floors, which can be decided only for each individual firm. Speaking broadly, the present tendency is towards isolation where the work done is of a sufficiently standardized and repetitive character to justify it.

But whatever arrangements are adopted, the cardinal element of economical haulage and handling must not be lost sight of. Raw materials—bars, castings, and forgings—should be taken in, and should, with the articles manufactured from them, not return on their tracks, but should progress from shop to shop, or department to department, in orderly sequence; and this idea must be uppermost when locating the positions of those departments in which preparatory work has to be done, as the casting, forging and plating departments, and the stores for iron and steel. Raw material should, as a rule, be utilized first nearest the point of debarkation. The heavy machine shops into which castings and forgings have to be taken should be located nearer to the foundry, forge shop, or boiler shop than the department in which light work has to be done.

It is well as a rule, when work is for the most part heavy, to conduct operations so far as possible on the ground level. There is, however, always a proportion, greater or less, of light work, and this can well be conducted on upper floors, or in galleries running round a shop, the latter usually having preference. In shops in which most of the work is light, as in the manufacture of small motors, brass fittings, and articles of similar bulk, floors and elevators can properly be utilized. But lack of light renders fine work difficult on dark days and runs up the bill for gas or electricity.

Instead of building in the heart of a crowded city, most new factories are now erected in the suburbs of cities, or out in the country where ground is cheap and room for extension is ample, and where healthful cottage homes can be built for the workmen.

The arrangement of shops on a ground floor only is the modern ideal in factory design, and it is one which is admirably suited for engineering works. The work being mostly of a heavy character, its manipulation is awkward on upper floors, but if it can all be dealt with on a ground floor it can be run in and out, handled with hoists and cranes, while all the trouble of lifting and lowering from upper floors is avoided. Supervision, again, is easier on one floor than on several. A manager or foreman can have more men under more effectual observation, whereas different floors require either extra foremen or divided attention. Hoisting machinery can be more efficiently installed on a ground-floor shop than in a building of several stories.

With regard to the buildings themselves, it is better and cheaper to build one-story shops than those with several floors. The walls, having no floors to carry, need not be so thick, and there is no expense for heavy joists, floor planking or concrete. More light can be admitted from the roof than from windows in walls, and a north light can be obtained with a saw-tooth roof, which avoids the direct glare of sunshine. With regard to the walls, in most engineering works they are made to fulfil other functions besides that of sustaining the roof. Details which have to be considered are the support of travellers and jib cranes, of main lines of shafting and countershafts, and sometimes of machines, such as wall planers, drills, etc., in whole or in part. Brick walls alone are not nearly so suitable for the fulfilment of these functions as are metal columns. This is one cogent reason why columns are generally preferred to brickwork, and it is all in favor of the ground-floor shop in which columns take the place of brick walls as supports, the wall often being a mere filling in of a brick course, or even sometimes of sheet iron, between the columns.

Further, the modern shop ideal is to have an unbroken width across two, three, or half a dozen bays. Each bay has its own roof, but the bays are separated only by columns, which leave clear wide spaces across the entire width that is enclosed by the outer walls. The columns, of cast iron or structural steel, are made to suit exactly the requirements of the shop, with flanges and brackets to receive the gantries of overhead cranes, the pivots of swinging cranes, bearings for shafting or countershafts, and attachments for wall machines. In the event of future shop extensions these bays can be carried out lengthwise by making more identical columns, preserving the uniformity in width and height of the shop. In a well-lighted shop built on this model there is no objection to the erection of galleries of moderate width, provided they do not interfere with the employment of suitable hoisting tackle. They would sometimes block the way of an overhead traveller, but the latter is not required in light departments. Moreover, galleries need not occupy all the length, and they may be raised higher than the crane gantries. Where space is limited the galleried shops often offer the best solution of a difficulty.

Hoisting machinery is a costly item, and one in the laying down of which the best judgment is required. There are so many systems of hoisting adopted now that it is difficult to give statements of general application. But the following considerations should have weight. In the shops themselves the choice lies between overhead tracks with hoists, overhead travellers, and walking or single-post cranes. The choice of the first two should be favored because they leave an absolutely clear way beneath. But many firms employ the walking cranes, especially in machine shops. Wall cranes will often be needed both for light loads and the local service of heavy machines. Floor trolley tracks are often used. In the yards there should be travelling steam or electric cranes to go wherever required for unloading or loading, for hauling or pushing, in the absence of a yard locomotive.

The hoisting mechanisms for light service which run along the overhead tracks may be divided into two great groups; those which are trolleys only, having eyes from which the actual hoisting machines are suspended, and those that combine the travelling and hoisting tackle in one. The first-named are mostly of the direct lift types, worked by hand, pneumatic, or hydraulic power; the second are electrical. In the hand hoists pulley blocks are suspended from trolleys pulled along by hand. In the pneumatic and hydraulic types the movement of a piston or ram in a cylinder is equal to that of the lift. In electrical hoists toothed gears, drum and wire rope are employed, driven by the motor located on the trolley. The movements of the latter may be controlled from a distance, but more commonly dependent rods with handles are employed, so that the men standing by their loads can operate the hoist from the floor. So extensive are these developments that several firms in England and America make a specialty of the fitting of overhead tracks and light hoists for them. For heavy duty overhead travelling cranes are practically universal. They are made in many styles and powers to suit all conditions, operated from above and from the floor, and as a rule now each motion is provided with its own separate motor.

Alternative to the overhead tracks are the walking or single-rail cranes, which have for a long time been favorites in the machine shops of the Manchester district and north country shops. They occupy only the room in which they happen to be engaged for the time being, and the single line of floor and overhead rails does not block the shop much. As they are slewing jib cranes, they cover an area corresponding with the entire sweep of the jib.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD
MARINE AND MINING ENGINEER, THE SURVEYOR,
THE MANUFACTURER, AND THE
CONTRACTOR.

Present Terms of Subscription, payable in advance
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

Copies Antedating This Issue by More Than One Month, **25** Cents Each.
Copies Antedating This Issue by More Than Six Months, **50** Cents Each.
ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.

H. IRWIN, B.A.Sc., EDITOR.
A. E. JENNINGS, ADVERTISING MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7406** or **7406**, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."
Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 820, Union Bank Building. Phone M. 2914. G. W. Goodall, Western Manager.
London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.
Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

NOTICE TO SUBSCRIBERS.
When changing your mailing instructions be sure and give your old address in full as well as your new address.

Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada.

Vol. 24. TORONTO, CANADA, JUNE 26, 1913. No. 26

CONTENTS OF THIS ISSUE.

THE ENGINEER AND THE COMMUNITY.

Dr. George Fillmore Swain, in his presidential address to the American Society of Civil Engineers at Ottawa, last week, on the part for the engineer to play in the solution of some of the problems of the present day, unconsciously expresses himself as an engineer, among his fellowmen, with an astonishingly broad conception of the relationship of men of this profession to society in general. Frequently, in late years, writers have discussed the subject, and from both sides. Taking the definition of an engineer as one who, possessing a knowledge of the laws and properties of matter, designs and constructs, and, realizing the superior facilities of communication, transportation, food preservation, water purification, etc., as the works of the engineer, the question of what he owes to society is lost in that concerning how much society owes to him. On the other hand, the reason why the engineer does not receive the praise and credit which is his due, has often been attributed to the aloofness with which he holds himself from the discussion of public improvements and the administration of governmental departments and affairs.

Rear Admiral Geo. W. Melville, retired from the United States Navy, in discussing the engineer as a citizen, stated a few years ago:—

"In view of the enormously important part which the engineer plays in the life of to-day, it is incumbent upon him, more than upon most other men, to take a vital interest in the work of government, and to lend his trained ability and judgment to its perfection. I do not mean, of course, that the engineer should do routine professional work for the governments without compensation, but that in the discussion of public improvements and the administration of governmental departments he should take an active public stand to influence and guide the non-expert part of the population.

"It is notorious that enormous amounts of money have been squandered on great public works because they were undertaken in a way which every engineer knew must be inefficient and uneconomical. If all of us as engineers had a keen sense of our duty in this respect, and would properly utilize our experience and ability through the daily press, the magazines, and the reviews, by public discussion and in the daily intercourse of life, as well as by impressing the truth upon our representatives in municipal and national affairs, I believe we should accomplish an immense amount of good."

Prof. Swain's address is one from a viewpoint not frequently found in the writings of engineers, and his masterly treatment of the undesirable phenomena to be found on the increase among men to-day should receive every reader's attention.

ENGINEERING CONVENTIONS.

These are convention days among engineers. This week has such an array of professional gatherings that doubtless the old saying that engineers are content to work, leaving the talking and the management to the lawyer and the politician, will be criticized by the wayfarers in other walks of life, who find them gathered together in hall, hotel, or railway carriage.

Of world-wide interest is the Third International Roads Congress, opened on Monday in London, Eng., and continuing throughout the week. The period of continued activity in road reform that has prevailed since the second Congress, three years ago in Brussels, has seen many methods, and not a few materials, introduce themselves, and pass from the experimental to the prac-

tical stage. Further improvements in methods of road construction and maintenance will be disclosed, to the thirty-six countries of the world represented there, and the newest information now available will be dispensed from these various sources, with regard to climatic influences, heavy trafficking, dust prevention, longevity of surfacings, frequency of renewals, etc. As it stands, technical knowledge of road-building is far in advance of road administration to govern it, and it is to be hoped that the Congress in London will bear fruit in much-needed data concerning road costs.

In Toronto the Canadian Electrical Association is in convention on the 25th, 26th and 27th, and not in Fort William as had previously been announced. Arrangements for convening in the latter city were not satisfactorily arrived at, and Toronto was chosen as the place of meeting. Technical papers are being presented at the Wednesday and Thursday sessions, and the balance of the assembly is being given over to excursions and entertainment.

The American Waterworks Association, in session at Minneapolis throughout the week, is fortunate in the choice of city. No doubt the immense filtration plant, representing the latest word in water purification, will receive its share of visitors. Authoritative papers are being read on such subjects as water purification, fire protection, ground water, rate-making, franchises and watersheds.

The American Society for the Promotion of Engineering Education holds its annual meeting this week also, and has likewise chosen Minneapolis as its city. The care and attention which this society is devoting to engineering training merits the approval of all associations in general and of individual engineers.

The American Institute of Electrical Engineers are meeting in Cooperstown, N.Y. It is their thirtieth annual convention. Some twenty papers are being presented, and many Canadian members of the Institute are in attendance.

The American Society for Testing Materials is in convention, June 24th to 28th, at Atlantic City, while the American Institute of Chemical Engineers hold their semi-annual meeting at Boston, Mass., June 25th to 28th.

PUBLICITY IN CALLING FOR TENDERS.

Unless the proposed extension is for the most part a duplication of a previous installation, manufacturers of engineers' and contractors' supplies usually expect reasonably wide publicity in the matter of requirements, being constantly on the lookout for the solicitation for tenders. In the case of a town or city, it is the general rule to purchase supplies by tender, the transaction being of such great interest to ratepayers, and not to a limited few. In some corporations the rule is rigid. Much valuable information is to be gained in dealing with the proposal submitted by tenderers, whatever the requirement may be. It is of value not only to the purchaser, but to other municipalities, and it is strange that the rule is not followed without exception.

Instances frequently come to light, however, where discrimination is practised to excess, and where forms are sent to a very small and promiscuously chosen percentage of those well prepared to submit competitive quotations on reliable supplies. Recently *The Canadian Engineer* was asked by a pipe manufacturer why a certain call for pipe and valve tenders had not appeared in its columns. Upon investigation it was found that the want, although of a city, was not advertised in any paper. Apparently it has long been the custom of the city authorities to send notice of the material required to several manufacturers only, although the city engineer is strongly in favor of widespread publicity for the benefit of other supply houses. In this case the award was made to a local firm before knowledge of the existence of the proposed extension requirements was made known to others.

Presumably it is not the desire of municipal engineers to entertain methods so unproductive and so risky. The value to them of a thorough knowledge of what firms can do in the matter of quality and prices is significant, and civic officials are not up-to-date who do not recognize the value of the competitive tendering that is ensured by advertising their calls for tenders in the technical press.

EDITORIAL COMMENT.

July 15th, 16th and 17th are the dates of the annual Convention of the Union of Canadian Municipalities in Saskatoon, Saskatchewan. Questions bearing upon public utilities, town planning, garbage incineration, water purification and the like will be discussed.

* * * *

The Fourth Annual Convention of the Pacific Highway Association will be held in Vancouver, August 11th, 12th and 13th. This association has set itself about to secure the construction of a first-class trunk road along the Pacific slope, and, with the co-operation of the Governments of both countries, and the communities along the slope, an international roadway of great service should result. Previous annual conventions have been: 1910, Seattle; 1911, Portland; 1912, San Francisco.

* * * *

One of the first duties of the new city engineer of Ottawa, which position was assumed on the 20th inst. by Mr. Arch. Currie, C.E., is an investigation into the city water supply. It is well known that it is a difficult problem, and that the office of city engineer is, therefore, not devoid of troubles of its own. The waterworks staff has applied on two recent occasions for separation from the board of works staff. The Board of Control reported unfavorably concerning the division, and it is understood that the question is now awaiting solution by the new city engineer.

* * * *

The beautification of cities is receiving splendid attention in Ontario this season. *The Canadian Engineer* in last issue announced the proposed expenditure of $7,000,000 in a forty-two mile system of boulevards to surround the city of Toronto, the work being in charge of the Parks and Exhibition Committee, and being an entirely separate enterprise from the Harbor Commission's waterfront development work. It has just been announced that Section A of the system, extending from the lake to Bloor Street along the eastern bank of the Humber River will be gone ahead with this summer, $25,000 having been appropriated for this purpose. The Government has just announced a similar scheme to embrace Ottawa and Hull. A commission is to be appointed to prepare plans for the systematic development and beautification of the two cities with regard to parks, boulevards, public buildings, etc. The traffic and transportation problems will doubtless be included in this work, and the co-operation of the transportation companies is to be expected. The mayors of the two cities are to be members of the commission. Half the cost of the scheme of planning is to be borne by the government and the other half by the two cities.

TORONTO WATERWORKS EXTENSIONS

COMMISSIONER HARRIS EXPECTED TO MAKE THOROUGH REPORT NEXT MONTH — TWO MECHANICAL FILTRATION PLANTS — SCARBORO HEIGHTS SCHEME ABANDONED

Commissioner of Works R. C. Harris, of Toronto, is now gathering the final data for his report to the city's Board of Control regarding the proposed extensions to Toronto's waterworks system. The Commissioner's report will likely be presented to the Board next month, and tenders will be called for, very soon thereafter, for a new filtration plant.

The citizens of Toronto voted $6,000,000 on January 1st, 1913, for waterworks extensions. Although six months have passed since then, practically none of this money has been spent, and no official announcement has been made at any time as to why the Works Department of the city was not going ahead with the extensions. At a cost of about $26,000, a detailed report had been obtained by the city in 1912 from a board of four engineers, who were appointed, prior to the present administration of the Works Department, to advise the city of the best plan of making the necessary extensions to the available pure water supply. The board, consisting of J. G. Sing, chairman; Willis Chipman, secretary; T. Aird Murray, and Isham Randolph, reported in favor of a gravity supply system from Scarboro Heights, the water to be pumped from the bottom of the lake off Scarboro to the Heights, from which place it was to flow through from nine to twelve miles of pipe to the city, after being filtered at Scarboro.

This report was generally accepted, and when the citizens voted on the $6,000,000 by-law, it was popularly understood that the money was to be used in carrying out the board's report. Just about that time *The Canadian Engineer* pointed out a number of serious defects in the report which made the Scarboro Heights scheme seem entirely impracticable. *The Canadian Engineer* called attention to the greatly underestimated cost of the Scarboro Heights undertaking; to the possibility of getting the same result at a much cheaper cost by putting the plant at the Island, and using direct pumping instead of the gravity system; to the lack of flexibility of the gravity system; to the great waste of power in pumping water up to Scarboro Heights, only to expend the acquired head in friction when the water ran through miles of pipe to reach the city; and several other details that caused much comment in the public press at the time. The comments of *The Canadian Engineer* were actively replied to by three of the Commissioners, Mr. Murray, however, admitting the errors of the report in letters to the Mayor.

The other three members of the Commission met the City Council and endeavored to explain away the defects in the report that had been pointed out from time to time. The Commissioner of Works, however, laid the report of the experts to one side and decided to prepare a report of his own for the Board of Control, basing his report upon the experience and research work of the city's own engineering staff.

Consequently, the extension of the waterworks system was held up until the Commissioner's staff had secured such information that they were prepared to report with confidence to the Board of Control, advocating a scheme of extension far more practical than the Scarboro Heights scheme.

It is understood that after six months' careful survey of the situation, the Department of Works will in all probability advise the City Council to install a rapid sand filtration plant at the Island and to distribute the water to the city by direct pumping.

The report to be made by the Commissioner of Works early next month will be extremely thorough. The Commissioner has investigated every phase of the problem, and his report will undoubtedly overlook nothing that has any bearing upon the situation. The history of Toronto's existing slow sand filtration plant will be related, the difficulties that have been experienced with it will be explained, and the reasons clearly given as to why Toronto is now turning to rapid sand filtration.

A report will be given of the various types of filtration plants visited by the Commissioner of Works and other officials of the city during the past year, and recommendations will probably be made that the Board of Control call immediately for tenders for a rapid sand filtration plant of sixty million Imperial gallons capacity. Each tenderer will be required to file plans and specifications of his plant, together with his tender. Each tenderer will be required to guarantee the efficiency of his plant; the daily capacity, and the maximum cost of operation, chemicals, etc. The award will then be made to the plant which will cost the city the least money compared with the efficiency guaranteed. In computing this, the "cost" will include not only the first cost of the plant, but the capitalized cost of operation, chemicals, etc.

The water from this new plant will be brought across Toronto Bay through the existing tunnel, which has a daily capacity of from one hundred and ten to one hundred and twenty million gallons. As the existing slow sand plant has a capacity of only forty million gallons a day when not over-loaded, the tunnel will readily handle the one hundred million gallons per day total output of the two plants.

The city's electrical pumping capacity at the present time is fifty-four million gallons daily. The steam pumping capacity is fifty million gallons. A sixteen million gallon pumping unit is now being built for the city by the De Laval Steam Turbine Company, of New Jersey, and in all probability another steam unit will be installed at a later date. The steam pumping capacity will likely in time be brought up to the one hundred million gallons per day that the filtration plants will handle.

Under this scheme, however, Toronto would still obtain all of its water supply through the tunnel under the Bay. Should any accident occur to this tunnel, the situation would be serious; and, with this in view, the Commissioner will likely recommend in the near future that a filtration plant, of probably about sixty million gallons daily capacity, be located in East Toronto. It will not be located at Scarboro Heights, however. The water from the plant will likely be delivered to the East End by direct pumping. This plant will pump directly from the lake and will provide Toronto with a water supply independent of the tunnel.

Although Mr. Allen Hazen and his partners are still urging the city to stick to slow sand filtration, it is not likely, for a number of reasons, that the Commissioner

of Works will consider any tenders for plants that are based on slow sand filtration, but will consider only the gravity and pressure systems of mechanical filtration, and the drifting sand type of filter.

There are numerous plants on this continent of the first two types mentioned, but only one plant of the last type, and that is an experimental plant which is now in operation at West Toronto. It is a half million per day plant, and is filtering to waste. It was built entirely at the expense of the company that controls the patents on this type of filter, and was built to convince the Commissioner of Works that when calling for tenders he would be justified in giving consideration to a tender on this type of filter. The experimental plant has been in operation for a little over a month, and the results have been carefully watched by officials from the City Hall, and a tender on the drifting sand type of filtration will likely receive consideration by the officials, along with the tenders on the other two older and more widely recognized types.

As the western part of the city increases in population, another filtration plant similar to the one proposed for East Toronto will likely be installed at West Toronto, so as to make the city entirely independent of any one source of supply.

THE ENGINEER AND THE SOCIAL PROBLEMS

THE PROFESSION AS A PART OF THE SOCIAL ORGANISM — PRESENT DAY CONDITIONS AND TENDENCIES — PRESIDENTIAL ADDRESS, AMERICAN SOCIETY OF CIVIL ENGINEERS' CONVENTION, OTTAWA, ONTARIO, JUNE 17th TO 20th

By DR. GEORGE FILLMORE SWAIN, Pres. Am. Soc. C.E.

NOTE.—This article, a continuation of which will appear in next week's issue, is abstracted from Dr. Swain's address. Readers desiring copies of his paper, complete with references, footnotes, etc., may procure the same by applying to *The Canadian Engineer* for them. The paper isbeing prepared in pamphlet form and copies will be sent upon request as long as the supply lasts.—ED.

IN asking your attention this afternoon to the remarks which I shall offer for your consideration, I cannot forbear expressing to you, once again, my appreciation of the honor which you have done me in electing me to the position in which I find myself. It is a distinction which I shall always value above any other, and it involves a responsibility to the profession of which I am deeply sensible. This feeling, together with my conviction of the importance of our profession as a part of the social organism, has guided my choice of a subject for this address.

As we gather here, interested in widely divergent branches of engineering science, it has seemed to me that I could most profitably occupy the time by asking your attention to some matters in which we all should be equally interested. I have, therefore, chosen for my subject a consideration of some Tendencies and Problems of the Present Day, and the part which the engineer should play in their solution.

We are living in a most remarkable age, an age different from any that has preceded it in the history of the world, and and one in which changes are taking place with marvelous rapidity. As a profession, we are largely responsible for the present conditions, and as such we should do our part in solving such problems as exist, and in helping to direct aright the tendencies of the day. We have a duty to ourselves, to our profession, to society, and to our successors, and we must perform it.

We have been often reminded of the fact that in one sense engineering is the oldest of the professions, since engineering constructions of some form are necessary even in the rudest communities. But in another, and perhaps a truer sense, it is the youngest of the professions. The priesthood is doubtless the oldest distinct profession recognized as such, for the most uncivilized tribes had priests to mediate between themselves and their crude deities. The priests were also law-givers, practiced the healing art (such as it was), and, as civilization progressed, were also the builders. Bridges and temples were built by them, and the most stately buildings were those devoted to ecclesiastical uses. In course of time, the lawgiver, the physician, the architect, became distinct, and then for a time the engineer was either an architect or a priest. It is fair to say that engineering is the last profession to be differentiated into a class by itself, and that its beginning dates from about the 17th century, and later received its great impetus from the series of inventions which were made toward the end of the 18th century; the spinning jenny, the loom, the puddling process, the steam engine, and the steam locomotive. Since that time, the profession has grown by leaps and bounds, has become separated into a dozen branches, and has probably become, directly or indirectly, the chief occupation of mankind. If this age may be designated as predominantly that of any profession, it is certainly the age of the engineer, or applied scientist. He furnishes us with thousands of comforts, necessities, and luxuries, of which previous generations never dreamed, and which they would have laughed at as impossible. By supplying the fundamental material elements of modern civilization—transportation, the transmission and dissemination of intelligence (by telegraph, telephone, and printing press) machinery, prime movers and the working of metals—the applied scientist becomes the minister to the other and older professions, furnishing tools for the surgeon and dentist, and chemical products for the physician; while engineering projects and problems probably supply as large a field as any for the employment of lawyers. The priest—originally lawgiver, physician and builder—now stands alone, concerned only with the moral law and its application, and with our relation to the Infinite.

Civilization, as we know it to-day, then, seems to me to be due mainly to the engineer, or applied scientist, using the term in its widest sense. Of course, a great ethical advance has also been made, of which any student of history must be fully conscious. But when we consider that moral principles were known and recognized by the ancients, in as perfect a form as that in which they can be stated to-day, without producing much of any widespread ethical progress or any advance in civilization for many centuries, we must, I think, conclude that it is the dissemination of intelligence, the facilities for transportation, the development of machinery, which have made the whole world kin, and thus have been

the chief elements in promoting the universal brotherhood of man and the practical recognition of human rights, and so have been the main agents in the progress of civilization. This, somewhat differently expressed, is, as I understand it, the position taken by Buckle, often misunderstood by those who assume him to assert that no ethical progress has been made. However this may be, few will deny that the work of the engineer, if not the cause, has been a necessary condition of progress.

This progress, both material and ethical, has been widespread and astonishing in degree. In material things, not only necessities, but comforts and luxuries of which our forefathers would never have dreamed, are now within the reach of every man who is sober and industrious. Wages have risen, not only in absolute amount, but in purchasing power. The poor can now receive medical advice, medicines, and many other things free, where our predecessors could not have obtained the same things at all. Simple foods in great variety, and clothing of good quality, can be obtained at reasonable prices, and in every respect the poor man to-day is better provided for than his predecessors were. Ethically, too, he is far better off. The best books are available, if he wants them, at ridiculously low prices, free public schools are provided for his children, and all sorts of free industrial and vocational instruction is available for him in his leisure hours if he desires to use them. His hours of labor have been shortened, his civil rights have been generally recognized, he is treated as the equal of any man before the law, and his right to a fair chance in life—to opportunities commensurate with his ability to make use of them—is generally admitted in theory if not yet entirely in fact. With free public and trade schools, with conditions which allow a common laborer in a steel mill at 15 years of age to become the head of the greatest industrial organization in the world at 50, certainly it cannot be said that men do not have opportunity in this country.

But, continued progress and the interest of the social organism as a whole, require that individual initiative and ability shall be encouraged to the utmost and allowed to enjoy the reasonable fruits of its exercises; that property shall be protected; that taxation shall be equitable and uniform; that leaders shall be chosen from those most enlightened, capable, honest and judicious; that those who are only fitted for manual labor shall not acquire a distaste for it or look down upon it as inferior in dignity to other occupations; and that waste and extravagance shall be reduced to a minimum. There should be a recognition of the facts that wealth must be unequally divided, since men are unequal in ability and in character; that the prosperity of one depends upon the prosperity of all; that each man must feel secure in the enjoyment of all that he can legitimately win; that wealth, position, and luxury, do not in themselves bring happiness; and that the selfish desires of the individual must be subordinated to the interests of society as a whole if progress and not retrogression is to ensue. A state of equality of condition, as has been well remarked, would mean equality, not of wealth, but of wretchedness.

The political and social evolution in the past has, up to a comparatively recent period, not involved any diminution of the incentive to individual effort, nor to any great extent the attempt to deprive the individual of the fruits of his industry and ability. Of late years, however, with growing political power in the hands of the less intelligent classes, symptoms of a change have shown themselves. The spectacle of isolated instances of great wealth acquired unfairly or too rapidly, and of rewards out of proportion to service, instead of being looked upon as necessary phenomena, seeing that men are human, and that no human affairs can ever be perfect, has lead to a widespread spirit of envy and discontent, and sometimes to a desire to deprive men of the results of their honest toil.

It is to some unfavorable phenomena incident to this movement that I wish to call your attention, believing that if they continue, disaster may result, in which case, as always, the suffering will mainly come upon those least able to bear it.

Equality Among Men.—What I conceive to be the true democratic ideal is this: that all men are equal before the law—so that neither differences in wealth, race, social position nor talent shall confer any advantage or impose any disadvantage in the impartial administration of justice; that while ability may be admired, every man who is honest, industrious, sober, and faithful, and who does his work in the world as well as he can and with due regard to the rights of others, is deserving of equal respect and regard, whether he occupy the humblest or the most exalted position; that success depends upon the spirit with which one's natural endowments are utilized and the degree to which they are developed, and not upon those endowments themselves, so that the humblest laborer on the street may be making as great a success of his life as the most gifted; that there should be kindliness and a spirit of brotherhood between all men and neither envy of those more capable, who receive greater rewards, nor contempt of those less gifted, who do the menial work of the world; and that neither race, poverty, nor inferior social position should prevent the possibility that a man, by hard work, integrity, and conscientiousness should be able to reach, by some available ladder, a position commensurate with his abilities. A man should be judged by what he is, not by what he has, whether he is black or white, or who his grandmother was. He should have the opportunity to get such education as best fits his natural qualifications. Rich and poor should be judged by the same standard—inherent worth. But though respect should be equal, rewards should not be, but should be in proportion to the value of the service, and governed by the law of supply and demand; nor are great rewards necessary for happiness.

Unfortunately, a democratic government, especially with universal suffrage, instead of tending to the realization of this ideal, tends in some respects directly away from it, and leads not seldom to the grossest perversions of it. The equality of man, which the framers of the Declaration of Independence held to be self-evident, instead of being interpreted as above, is held to mean that men are inherently equal in all respects.

It is self-evident that instead of being equal, men are very unequal. There is perhaps more difference between the most intelligent and the least intelligent voter than there is between the latter and an intelligent animal. It is held that all, being equal, should have equal opportunity. But why should there be equality of opportunity for unequal individuals? Inequality of opportunity for unequal men is a nearer approach to true equality than equal opportunity for unequal men. Why, for instance, should all men have opportunity for a college education, when only a few can profit by it, and the great majority should work with their hands, not with their heads? Not every man who is able to pass successfully through a college course is able to use it when he has finished, and many a good mechanic has by its means been spoiled to make a poor and discontented clerk or lawyer.

One of the conditions of individual progress is the willingness to recognize and admire superiority, and without envy to rejoice in its success. The idea of the equality of man limits this recognition, and so hampers individual progress, and therefore collective progress. In college, there is

little in class associations to stimulate a man to excel. If he does, he is termed a "grind" and is looked down upon. If all men are equal, he has no right to exhibit any superiority to his fellows. The same is true among the so-called laboring classes. No man must do any more work, or do it any better than another. Individual excellence and initiative are discouraged. Indeed, individual freedom is not seldom infringed upon, and a man is not allowed, at times, to work at wages satisfactory to himself, when he desires to do so—a strange result of freedom, and in reality as great an outrage as any that can be quoted from the medieval annals of despotism. With growing discontent, many minds turn to socialism, that impracticable Utopia which, as President Butler has well said, "would wreck the world's efficiency for the purpose of redistributing the world's discontent."

The idea of the equality of man, instead of allowing the best men to govern and fitting the man to the proper vocation, leads to the placing of unfit men in power, the control of large masses of men by demagogues, the judging of men by the number of votes they control; and thus it leads to the withdrawal of many of the best men from active participation in public affairs, because they see how little influence they can exert, and that the only reward of one who unselfishly serves the public is likely to be criticism and contumely. It also discourages loyal and faithful service, and makes difficult the maintenance of proper relations between employer and employees.

What the ultimate result will be, cannot be foretold. The political doctrine of the equality of man is still a trial. Yet, as regards the United States, where that doctrine has its present expression, Lincoln long ago observed that if it fails, it will not be on account of interference from without, but it will be by suicide. It behoves us, therefore, if we can, to see to it that our institutions shall not fail by suicide.

Nevertheless, it is a somewhat striking fact, that several of the most philosophical and learned historians have distrusted the ultimate success of our institutions. Froude, Macaulay and Lecky all express the gravest doubt of the permanence of our form of government.

These predictions will, we hope, prove erroneous. We must make them so if we can. Nevertheless, the more we reflect, the more I think we shall realize that out of the false theory of the equality of man, have sprung many real dangers. A spirit of unhealthy discontent has been aroused, and the people, who are sovereign, endeavor by various kinds of legislation, to realize in fact the untruth of equality. They make the common mistake of assuming that legislation is a sovereign remedy for all ills. Not knowing how to proceed, they become the prey of every selfish demagogue who, while stirring them up to exaggerate their troubles, and professing his ability to remedy them, is simply seeking his own ends. These men know that a large part of the voters to whom they must appeal are ignorant, easily swayed by claptrap and deceived by hypocrisy, "incapable of disentangling a difficult question, judging distant and obscure consequences, realizing conditions of thought and life widely different from their own, estimating political measures according to their true proportionate value, and weighing nicely balanced arguments in a judicial spirit." The demagogue therefore appeals to class interests and class animosities, and does his utmost to foment a spirit of discontent, even though every condition justifies the opposite, gaining his reward by newspaper headlines, notoriety, public office, or not seldom, wealth secured at the expense of the public that he deceives. The spirit of servility and sycophancy which in former times led men to grovel in the dust at the feet of kings and princes, is still with us, unchanged in form. Only its object is different, and its adulation is now directed to the sovereign voter—the more ignorant, the more easy to flatter and deceive. Knowing human nature, may we not doubt the man who claims to act for the good of the people; and trust him rather who frankly admits that his actions are governed by his selfish interests, but who has learned that these can only be served by promoting the best interests of all.

Some of the remedies for these dangers, it seems to me, are obvious. In the first place, we should realize that the statement that all men are created equal, properly interpreted, simply means that they are equal before the law, that all men should be treated with justice, should have fair opportunities, and that each should be secured in his right to the products of his own labor, and to his own liberty, so far as his acts do not injure others. Aside from this, instead of considering men equal, we should recognize and encourage inequality, for it is easily to be seen that the progress of society depends upon it. Equality of condition means pauperism or savagery; the inequality of man means the division of labor, progress, civilization.

In the second place, we should encourage the recognition and admiration of superiority.

In the third place, we should preach the gospel of content instead of discontent. There are two kinds of discontent; one praiseworthy; one ignoble. The former springs from a laudable ambition and a desire to perfect one's self, so far as natural endowment will permit. The other springs from envy and the desire to reap the rewards of the industry of others. The former kind of discontent is to be encouraged; every man should be given an opportunity to develop himself and to be confirmed in the possession of the prizes which he may gain. But the discontent which springs from envy, which leads men to depend upon government help, instead of self help, which sanctions forms of unjust taxation which may be nothing less than legalized robbery, should in every possible way be repressed. The attention of men, instead of being concentrated on what they want, should be more directed to a realization of what they have. In contrast with the conditions which existed one or two centuries ago, even the conditions of the poorest classes at the present time are immensely improved. Yet, with all the reduction of working hours that has taken place in the last 50 years, and the other improvements in condition, I doubt if there is any more real happiness and content among the poorer classes. Nor have I any doubt that the excessive talk about bettering the condition of the working classes, blinds them to the opportunities for their own thrift and industry.

Unfortunately, it is a vain hope that there will ever be an absence, or even a dearth, of demagogues to stir up this spirit of unworthy discontent, but we should do all in our power to counteract it. Unfortunately, also, much of it is due to the unwise use of wealth by those who possess it, who think that money can buy everything, and is the end and aim of existence, and who, instead of being governed by a feeling of the brotherhood of man, and the spirit of respect for true worth even in the humblest occupations, assume an attitude of superiority, or even of insolence, towards those less fortunate than themselves.

It is vain to hope that we can ever reach a point where there will be no poverty. This would realize what Dr. Johnson termed the triumph of hope over experience. It would mean a radical change in human nature. As long as there are masses of men who are shiftless, lazy, incompetent, and vicious, whom nobody would willingly employ, poverty will exist. Still, every effort should be made to relieve it where it is undeserved. It will be well, however, to bear in mind that suffering is a remedy, and that unwise philan-

thropy may do harm instead of good. If men will learn in no other way the lessons of life, they must learn them by suffering, which is Nature's cure. Of course, it is often hard to distinguish deserved from undeserved suffering. The latter may be wisely relieved; the former generally not. Surely an all wise Creator would not have filled the world so full of it except for some good purpose, and that purpose cannot be to afford to others the opportunity for relieving it, for much of it cannot be relieved.

The Tendency to Disregard Authority.—Out of the tendency to look upon all men as equal, spring some other tendencies to which I will refer. One of them is to disregard authority, and to consider that one man's opinion is as good as that of any other. We see this tendency about us every day; it leads to intellectual arrogance, dognatism and lawlessness.

Every man has presented to him, almost daily, questions which he is not competent to decide for himself, either because he has not had the necessary time, training or experience, or because he is incapable of judging.

In these days when literature is so superabundant, it is most important to choose our advisors wisely, to know whom to trust, to discern wisdom, to select the proper books to read, to choose the best authorities to whom we shall listen, and, when we have so chosen, to consider attentively the message they bring, and to distinguish advice that springs from self-interest from that which is disinterested. There is a great temptation to form hasty or immature judgments on slight authority, and the habit, once formed, may be difficult to eradicate.

The disregard of authority is peculiarly observable in the younger generation. It is not confined to the uneducated, but is even more observable in many whose self-esteem has been increased by a course in college. Finding that men disagree on almost every subject, and that even those in positions of authority do not hold the same opinion, it is easy to conclude that one man's opinion is as good as another's. Let us examine this matter further.

The subjects of study may be broadly divided into three classes: 1st, the relations of abstract ideas, that is, mathematics and logic; 2nd, natural science; 3rd, the so-called humanities.

With regard to subjects in the first class, no observation or experience is necessary, and there will be no differences of opinion. They are not, properly speaking, matters of opinion at all. There can be no discussion as to whether two and two make four, or as to whether the three angles of a triangle amount together to two right angles.

With regard to natural science, conclusions depend to some extent upon observation, experiment, and experience Hypotheses may be formulated, experiments made, conclusions deduced therefrom, and differing conclusions may be arrived at by different persons. In this class then, there may reasonably be divergencies of opinion. These subjects are, therefore, less definite, more hypothetical, more uncertain. than those in the first class.

Under the third class are comprised what are called mental and moral philosophy, politics, government, history, language, etc. This class of subjects is even more uncertain and less definite than the second. Experiments are less applicable and less likely to lead to definite results, the data are more shifting and variable, experience is of great value, and extreme differences of opinion will often occur.

The thoughtful man will recognize these differences between the various subjects of investigation. He will form his conclusions upon subjects in the first class with definiteness and certainty, and will be justified in feeling confident of their correctness. He will recognize the greater indefiniteness of subjects in the second class, and if he forms definite opinions, he will hold them in a sort of tentative manner, realizing that the next experiment or discovery, or greater experience, may show them to be incorrect. He will realize the still greater indefiniteness of subjects in the third class, and while he may well form definite opinions regarding these also, he will hold them with still greater modesty, realizing that in almost every question of this character there is much to be said on the other side, and that he may be entirely wrong. Only the man who has studied the subjects in all three of these classes will realize fully the different degrees of certainty attaching to each. Such a man will be much more modest and safe in his conclusions than a man who has studied only one class of subjects. It may further be remarked that a man who has studied only the third class of subjects, will be likely to be more dogmatic and less safe than a man who has studied the first or the second, or both, because not being familiar with subjects in which a great degree of certainty, or even absolute certainty, is attainable, he may assume that such degree of certainty is attainable in the subjects of the third class; whereas, a man who has studied mathematics or science, and is accustomed to definiteness, will, when he is confronted with problems of politics, government, or ethics, be at once struck with the great difference in reliability of the data, the impossibility in many cases of making crucial experiments, and the fluctuating conditions involved. For this reason, it is not uncommon that scientists, mathematicians, or engineers hold and express opinions regarding politics, economics or ethics, with much less dogmatism than less well-informed men who have devoted their attention more strictly to these last-named subjects.

(To be continued.)

TRADE DISPUTES DURING MAY.

The record of trade disputes maintained by the Department of Labor shows that, as is usual at this season, the majority of the disputes occurred pending the adjustment of new wage schedules. These were nearly all of short duration. The mining industry on Vancouver Island was seriously interfered with, more than 3,000 men being out during the whole month through the continuance of the dispute at Ladysmith and Cumberland mines, and the closing down of the mines in the Nanaimo District. A great number of the disputes of the month occurred among workers in the metal trades. The disputes of May affected upwards of 11,500 employees and accounted for the loss of more than 150,000 working days. Disputes affecting various classes of municipal employees in Vancouver and affecting also the boot and shoe workers in a number of the factories in Quebec were satisfactorily adjusted during the month through the instrumentality of boards under the Industrial Disputes Investigation Act. The Department of Labor also assisted in the adjustment of disputes affecting the employees of the Hydro-Electric Commission in Toronto, and affecting also the longshoremen in Montreal and St. John, N.B. In the latter case a board has been established under the Industrial Disputes Investigation Act.

During April, 1913, the exports of Canada to the United States amounted in value to \$8,763,013, which is \$497,334 less than those of April, 1912. Her imports from the United States for the month were \$37,416,217, exceeding corresponding figures of last year by \$6,416,998.

CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS AT OTTAWA.

The American Society of Civil Engineers held its 45th annual convention in Ottawa at the Chateau Laurier, June 17 to 20th. The convention was held under the auspices of the Ottawa members of the American and Canadian Societies of Civil Engineers. A detailed programme of the occasion was given in May 29th issue of *The Canadian Engineer*, and it is timely to state here that the proceedings of the convention were carried out in a most exemplary manner. The meeting was largely of a social nature, which necessitated more than ordinary care and attention, and the resulting comments pertaining to the proceedings point decidedly to most admirable management.

It is 32 years since the American Society of Civil Engineers held its previous convention on Canadian soil. During the years which have elapsed since, the engineering profession in both the United States and Canada has undergone a very marked development, and while we cannot give our readers much information concerning the convention of 1881, which was held in the city of Montreal, we feel quite sure that the convention held last week in Ottawa eclipsed all conventions which the society has held up to date.

The number of delegates registered totalled something like 385, including the ladies. The convention opened on the afternoon of the 17th with a reception to the visitors, the reception duties, in the absence from the city of the Premier, falling upon the Hon. Martin Burrell, Minister of Agriculture. This event took place in the Chateau Laurier. In the afternoon of the same day, the president and officers of the American Society of Civil Engineers held an informal reception in the ballroom of the Chateau, followed by a dance.

Wednesday morning at 10 o'clock the convention was called to order at a business session and the president's address, which was undoubtedly the outstanding feature of the convention, was delivered. Prof. Swain presented an address that for thought, logical sequence, reasoning power and rhetoric, will stand unique for a long time to come. It was a classic, and during the days of the convention following the presentation of the address, it was a constant topic of conversation everywhere among the delegates. A part of this address is published in another portion of this issue.

Following the business meeting a luncheon was tendered to the visiting members by the Ottawa branch of the Canadian Society of Civil Engineers in the main dining-room of the Chateau Laurier, Mr. R. F. Uniacke, of Ottawa, occupying the chair. At his right sat Prof. Swain and on his left Sir Wilfrid Laurier. There were but two toasts, one to the King and another to the President of United States. The toast to the King was responded to by Sir Wilfrid Laurier and that to the President of United States was responded to jointly by Prof. Swain, president of the American Society of Civil Engineers, and Consul-General Foster, of Ottawa.

A Few of Those in Attendance at the Ottawa Convention.

The members and ladies then proceeded to the home of Thomas C. Keefer, C.M.G., who is a past president of the American Society of Civil Engineers, at the Manor House, Rockcliffe Park. This was a most delightful occasion. The day was perfect and it permitted the engineers of Canada and the United States to mingle in a most congenial manner.

The evening of that day was given over to three or four short illustrated talks in the ballroom of the Chateau Laurier. Mr. David A. Molitor, C.E., consulting engineer of the Toronto Harbor Commission, gave a very clear and lucid description of the Toronto Harbor Commission's work, and showed by means of a large-sized chart what that commission had set out to accomplish toward the improvement of the Toronto harbor. Mr. C. R. Coutlee, of Ottawa, gave a very interesting talk on the railway situation, while Mr. J. B. Challies, superintendent, Water Power Branch, Department

of the Interior, and Mr. R. F. Uniacke, chief engineer of the Transcontinental Railway, also delivered addresses, both illustrated by lantern slides.

Thursday was spent in visiting points of local interest. In the afternoon the delegates and the lady guests were treated to a three-hours' tour around the city, terminating at the residence of Mr. Collingwood Schreiber, C.M.G., consulting engineer to the Canadian Government, where the members and their ladies were entertained at afternoon tea.

On Thursday evening a reception was tendered by the Ottawa members of the Canadian Society of Civil Engineers to the members of the American Society of Civil Engineers and ladies attending the convention.

Special reference should be made to the work done by the combined committees of the Ottawa members of the American Society and the Canadian Society of Civil Engineers in arranging the details for the entertainment of the visitors while in Ottawa. It was no easy task which these men undertook and that they did their work to a nicety was evidenced by the expressions of appreciation on the part of the visitors. This committee did its work with a thoroughness that was noticeable to all present, and we are glad to pay tribute to them in this way. The committee consisted of the following: Lieut.-Col. W. P. Anderson, C.M.G.; A. W. Campbell, A.M. Can. Soc. C.E.; W. A. Bowden, B.A.Sc., M. Can. Soc. C.E.; C. R. Coutlee, M. Am. Soc. C.E., M. Can. Soc. C.E.; S. J. Chapleau, M. Am. Soc. C.E., M. Can. Soc. C.E.; J. B. Challies, A. M. Can. Soc. C.E.; K. M. Cameron, A. M. Am. Soc C.E., A. M. Can. Soc. C.E.; A. R. Dufresne, M. Am. Soc. C.E., M. Can. Soc. C.E.; A. A. Dion, M. Can. Soc. C.E.; Sir Sanford Fleming, M. Am. Soc. C.E., M. Can. Soc. C.E.; Gordon Grant, M. Can. Soc. C.E.; Thos. C. Keefer, C.M.G., Past President Am. Soc. C.E., Past President Can. Soc. C.E.; C. H. Keefer, M. Am. Soc. C.E., M. Can. Soc. C.E.; T. C. Keefer, Jr., A. M. Can. Soc. C.E.; Major R. W. Leonard, M. Can. Soc. C.E.; A. St. Laurent, M. Can. Soc. C.E.; E. D. Lafleur, M. Can. Soc. C.E.; A. Langlois, A. M. Am. Soc. C.E., M. Can. Soc. C.E.; A. B. Lambe, A. M. Can. Soc. C.E.; Lieut.-Col. G. S. Maunsell, A. M. Can. Soc. C.E.; G. A. Mountain, M. Can. Soc. C.E.; D. W. McLachlan, A. M. Am. Soc. C.E., A. M. Can. Soc. C.E.; J. Murphy, A. M. Can. Soc. C.E.; J. B. McRae, M. Am. Soc. C.E., M. Can. Soc. C.E.; E. H. Pense, A. M. Am. Soc. C.E., A. M. Can. Soc. C.E.; Collingwood Schreiber, C.M.G., M. Can. Soc. C.E.; W. J. Stewart, M. Can. Soc. C.E.S; J. M. Somerville, J. Taylor, A. M. Am. Soc. C.E., A. M. Can. Soc. C.E.; R. F. Uniacke, M. Can. Soc. C.E.; G. W. Volckman, M. Am. Soc. C.E., M. Can. Soc. C.E.; James White, M. Can. Soc. C.E.

The following members of the Canadian Society of Civil Engineers were among those who registered: Peter Charton, Montreal; T. C. Keefer, Ottawa; Chas. H. Keefer, Ottawa; A. W. Robinson, Montreal; Wm. McNab, Montreal; G. H. Duggan, Montreal; D. W. McLachlan, Ottawa; J. A. Jamieson, Montreal; David Molitor, Toronto; A. B. Lambe, Ottawa; F. X. T. Berlinguet, Three Rivers; Phelps Johnson, Montreal; A. M. Bouillon, Quebec; H. R. Safford, Montreal; J. H. O'Brien, Montreal; Henry Holgate, Montreal; E. Jodoin, Montreal; A. Coussineau, Ottawa; Paul A. Bique, Montreal; G. W. Volckman, Ottawa; J. A. V. Beaudry, Montreal; Col. W. P. Anderson, C.M.G., Ottawa; C. N. Monsarrat, Montreal; W. H. Breithaupt, Montreal; G. H. Bryson, Brockville; J. W. Doty, Montreal; E. H. Pense, Ottawa; F. R. Redpath, Montreal; W. O. Houston, St. Thomas; S. Bray, Ottawa; G. R. Heckle, Montreal; R. F. Uniacke, Ottawa; H. M. Davy, Ottawa; A. S. Going, Montreal; A. T. Tomlinson, Montreal; Gordon Grant, Ottawa; A. J. McCool, Ottawa; J. A. Robert, Ottawa; E. O. Sullivan, Montreal; A. W. Sullivan, Valleyfield, Que.; E. J. Walsh, Montreal; C. H. Mitchell, Toronto; A. M. Beale, Ottawa; B. E. Norrish, Ottawa; L. M. Edwards, Toronto; A. E. Brooke, Toronto; John Kennedy, Montreal; J. J. Salmond, Toronto; Prof. C. H. McLeod, Montreal; J. K. Scammell, St. John, N.B.; E. C. Keefer, Toronto; Alexander McDougall, Ottawa; A. A. Dion, Ottawa; H. A. Burson, St. Catharines; Wm. Storrie, Ottawa; C. O. Wood, Ottawa; F. H. Byrne, Ottawa; C. A. Bigger, Ottawa; J. B. Challies, Ottawa; R. Steckel, Ottawa; F. H. H. Williamson, Ottawa; R. F. Davy, North Temiskaming; A. G. Genest, Ottawa; Sidney B. Johnston, Ottawa; C. V. Johnston, Ottawa; E. V. Johnston, Ottawa; O. Higman, Ottawa; J. B. Hunt, Ottawa; W. S. Lawson, Ottawa; A. C. St. Laurent, Ottawa; V. Valiquet, Ottawa; Alexander Bailey, Ottawa; J. P. Laforest, Hull; G. G. Gale, A. E. Smaill, Ottawa; N. Cauchon, Ottawa; J. T. Farmer, Montreal; H. A. Woods, Montreal; C. D. Sargent, Cornwall; J. H. Garbden, Montreal; J. T. Johnston, Ottawa; M. C. Hendrie, Ottawa; W. F. M. Bryce, Ottawa; C. H. Attwood, Ottawa; G. H. Ferguson, Ottawa; G. P. Hawley, Cedars, Que.; W. D. Bergman, Montreal; K. M. Cameron, Ottawa; M. F. Cochrane, Ottawa; E. S. Mills, Ottawa; J. H. Brace, Cedars, Que.

INSURANCE ENGINEERING.

Considerable interest has been awakened in engineering and manufacturing circles in Canada by the formation at Montreal of a firm that might be called insurance consulting engineers. Just as other consulting engineering firms specialize in various branches, such as waterworks, or bridges, or factory construction, etc., this firm specializes in expert insurance engineering knowledge.

The firm name is E. M. Sellon & Company, Limited, with offices at 136 St. James Street, Montreal, and the personnel of the board of directors is sufficient recommendation for a wide-spread knowledge of the firm in regard to the business they are undertaking. The directors are E. M. Sellon, M.I.E.E.; J. J. Creelman, Professor of Railway Economics at McGill University; and Mr. Lawford Grant, president of the Canadian British Insulated Company, and honorable secretary for Canada for the Institute of Electrical Engineers of Great Britain.

This firm considers that insurance is a science, and requires expert treatment. A skilled force of engineers and inspectors is maintained to advise in regard to the insurance of industrial undertakings. They inspect industrial risks at their own expense, and thus secure at first hand the full information which is necessary to obtain rating at the minimum tariff. Such inspection frequently enables the firm to make suggestions on fire protection which add security and more than pay for themselves. In these cases the client places the insurance through the firm in the same manner as it would be placed through any firm of insurance brokers.

When new construction is proposed, however, the firm places its knowledge of fire protection and of the many matters which govern insurance rating at the disposal of the engineers and architects who have charge of the construction, the insurance then also being placed with the firm in the usual manner. There is undoubtedly considerable opportunity for decided success for a firm in Canada specializing in this work, as the minimizing of the fire hazard, and the increasing of what might be called "fire-proofness," is a subject of vital interest to every manufacturer.

New Westminster ratepayers have approved by-laws aggregating nearly $600,000, as follows: street, $200,000; light, $40,000; waterworks, $45,000; schools, $55,000; sewers, $150,000; firehalls, $25,000; civic stables, $15,000; exhibition, $25,000.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

Book Reviews:

BOOK REVIEWS.

Manual of Public Utilities (first annual number). Published by Poor's Railroad Manual Company, 535 Pearl Street, New York; 1,924 pp. Price, $7.50, postpaid.

This manual is devoted entirely to statements of public service corporations, such as street railway, gas and electric light, water, power, telephone and telegraph companies. It is a record of about 8,500 corporations, or practically every public utility in Canada and the United States.

The general index contains the names of merged companies, with references to the companies into which they have passed. The balance sheets and income accounts of the more important companies are presented in comparison with those of other years, so as to show the rate and extent of growth and development, supplying thereby the necessary data upon which to form an opinion of the value of their securities.

The manual contains reference to a larger number of public service corporations and their standing than does any previously published work.

Emery and the Emery Industry. By A. Haenig. Translated from the German by Charles Salter. 104 pp.; 5 ins. x 7 ins.; 45 illustrations; tables; bound in imitation leather. Publishers, Scott, Greenwood & Son. London, England. Price, $1.50 net.

This little work in three chapters deals with the growth of industry of abrasives and grinding machines attendant upon the development of the machinery industry. A neat historical introduction is followed by a chapter on natural and artificial abrasives, together with considerable space devoted to carborundum—its properties, methods of manufacture, output, etc. Chapter II. enters upon the preparation and complete treatment of emery wheels and discs, taking into consideration hardness and grain of material, binding medium and allowable peripheral velocity, stability and capacity of grinders, and points in their mounting, use and experimental tests. The next chapter is based upon the various types of grinding machines and their special uses.

The book closes with a valuable list of references, for the most part from the German, and a very complete index. The volume is well printed and handsomely bound, and the subject matter has been treated in a clear and most interesting manner. It will be of value to all laymen, tradesmen and engineers in mechanical circles.

Steam Engineering. By W. R. King, U.S.N., Principal Baltimore Polytechnic Institute. Publishers, John Wiley & Sons. 450 pp.; 6 ins. x 9 ins.; cloth. Price, $4.00 net.

The number of books along this line is increasing with such rapidity that very much originality can scarcely be expected in any of them. The author of this book, however, does not claim originality for his work, but feels that the systematic arrangement and simplicity attempted are worthy of merit.

Considerable space has been devoted to each of the parts of a power plant, such as the boiler, the engine, the condenser, etc., and as the engine is a very vital and probably the most intricate part, the method of designing and testing it has been gone into with some detail. The action of the simple slide valve is explained, and an entire chapter is devoted to the use and construction of the Leuner valve diagram.

The design of simple and compound engines is discussed, together with the general advantages of compounding and the method of combining the diagrams of these engines. There is only one chapter devoted to the turbine, and one-half of this is devoted to the de Laval make.

A five-page chapter on Entropy does not seem to be of much assistance to the general policy of the book, owing to its brevity, and one feels that it should have been longer, or else entirely omitted.

The whole order adopted in the book is very unusual, but the matter contained should be helpful to those without a close technical knowledge of the science of steam engineering, and, on the whole, the work is sufficiently simple as to be very easily understood.

A Text Book of Thermodynamics. By James R. Partington, M.Sc. Publishers, Constable & Company. 542 pp.; 5½ ins. x 8½ ins.; cloth. Price, $4.20 net.

This book has been written with special reference to chemistry, and is a mathematical treatment of the science of thermodynamics, the illustrations and applications applying almost entirely to chemistry.

The first chapter on thermometry and calorimetry, which deals with such matters as thermometers and the specific heats of substances, is followed by two chapters discussing in some detail the first and second laws of thermodynamics, on which the rest of the book is naturally based. These laws are then taken up in their general applications to fluids, and following this two chapters deal with their special reference to the perfect and permanent gases and vapours.

The remaining half of the book gives the special applications of the science to chemistry, containing chapters on thermochemistry, gas mixtures, the general theory of mixtures and solutions, capillarity and absorption, the kinetic theories and other kindred subjects.

The work is very nicely gotten up, but, as the calculus has been freely used, the book would be of little value to anyone not having sufficient mathematical training. To the

advanced student, however, it should prove of considerable value.

Iron and Steel Constructional Work. By Karl Schindler. Translated from the German and adapted to English practice by Charles Salter. Publishers, Scott, Greenwood & Company, London, England. 140 pp.; 5 ins. x 7 ins.; 115 illustrations; cloth. Price, $1.00 net.

The book is divided into five sections, the first of which is devoted to cast iron and mild steel columns, with reference to calculation for compression, eccentric loading, etc. Tables of inertia of various shapes are given for each. Section II. deals with girders and beams and the methods of loading, girder connections, rivetted girders, and contains an additional chapter on floor construction. The next section comprises four chapters on roof construction, dealing with loads, roof principals and trusses, together with their calculations and details. The construction of iron staircases is dealt with carefully by precept and example. The last section of the book is devoted to skylights of various types, floor lights and glazed roofing. At the end are five-place logarithmic tables, antilogarithms, trigonometrical functions, tables of squares, cubes, etc., and of metric equivalents.

The book is carefully written, and forms a compact little structural handbook, with examples suitable for practical application. The illnstrations are clear and appropriate, and the notation used throughout conforms well with that in general use.

Resuscitation.—By Dr. Chas. A. Lauffer, Medical Director, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Publishers, John Wiley & Sons, New York. 47 pp.; 4 in. x 7 in.; cloth bound. Price, 50 cents net.

This book includes a reprint of a paper on this subject delivered by the author before the Philadelphia section of the National Electric Light Association. The author, after explaining a number of successful results which have been obtained from employing resuscitation methods on men who were supposedly dead, gives a clear description of the mechanism of respiration, illustrating same by a number of views of the various parts of the anatomy.

The Prone Pressure, or Schafer, method of resuscitation which has been adopted by the National Electric Light Association, and a number of other engineering societies, is described in detail.

This book brings out in a clear, concise manner the necessity of people in general being versed in the principles of resuscitation, and clearly shows how they can become sufficiently learned to prove of valuable assistance in the ordinary walks of life.

Solution of Railroad Problems by the Slide Rule. By E. R. Cary, C.E., Professor of Railroad Engineering and Geodesy, Rensselaer Polytechnic Institute. Publishers, D. VanNostrand Company, New York. 136 pp.; 4 ins. x 6 ins.; cloth. Price, $1.00 net.

This work is a compilation for the use of the civil engineer of the many ways in which his slide rule can be of extraordinary benefit. Numerous illustrations, examples and formula display methods whereby the instrument may be used with comparative accuracy, and a great saving of time, in the laying out of simple, compound, vertical or easement curves, and turnouts. A chapter is also devoted to its application in computing earthwork.

The first chapter deals with the slide rule alone, its description and method of operating in the solution of problems in general. Throughout the remainder of the text and under headings stated above are forty problems accompanied by forty-three illustrations and numerous tables. The book closes with tables of contents and a series of 114 formulas bearing upon railway track work.

In the working of the decimal point the author departs slightly from the practice recommended by slide rule booklets of keeping track of it in each operation. He recommends a mental calculation to ascertain the position of the decimal point in the result. This is the practice of many slide rule users, its only disadvantage being liability to err owing to mental occupation upon other parts of the calculation. Again, the manufacturers' instructions are the quicker, and, on the whole, are to be recommended.

An engineer will find the book of great use to him in railway work.

A Text-Book on Trade Waste Waters—Their Nature and Disposal. By H. M. Wilson and H. T. Calvert. Publishers, Messrs. Charles Griffin & Co., Limited, London, W.C. 450 pp.; 74 illustrations; 6 in. by 9 in.; cloth. Price, $4.50 net.

The book is written primarily from the standpoint of the sanitarian, and aims to show the means by which the waste liquids of industry can be disposed of so as to prevent pollution of streams or other sources of public water supply. However, with the characteristic thoroughness of English text-books the authors pay due attention to the commercial value of by-products, and fully discuss the various means that are adopted in order to recover materials of value from factory waste.

The book is technical, yet, owing to the many and various indnstries dealt with, peculiarly interesting. The plan throughout has been to describe the processes of manufacture which give rise to the waste water under discussion and to then describe the liquid and the treatment necessary. By this means the book becomes intelligible alike to layman and engineer.

"Trade Waste Waters" should prove valuable to all those who have the care of public water supplies, to the engineer who must advise them, and to the manufacturers, to whom it may mean not only the avoidance of a public nuisance but often a considerable economy of production. It brings into one volume the related matters of an extended literature, to which by copious bibliographies the reader is referred. The only exception that might be taken by a Canadian reader would be that the book relates almost wholly to English conditions and practice. English law in regard to stream pollution is the burden of practically two chapters. But even if in this regard it will not serve as a text-book of Canadian practice, that fact does not seriously detract from the value of the book.

Percentage Compass. For navigators, surveyors and travellers. By John C. Fergusson, M. Inst. C.E. Longmans, Green & Co., London, Eng. Unmounted, 75 cents; mounted, $1.10.

This comes in the form of a chart which is calculated to simplify the use of the compass and to effect a great saving in all angular computations. By means of this chart the surveyor and the traveller or the navigator can find as he goes along: First, the difference of latitude and departure: second, the closure angle of a compound traverse; third, the length of the closure line; fourth, by the use of the circular scale C it is possible to solve any problem in plain trigonometry by simple arithmetic. The percentage compass is a practical application of Fergusson's percentage unit of angular measurement of the magnetic compass dial, which converts it into a simple and accurate range finder.

PUBLICATIONS RECEIVED.

Annual Report of the City Engineer of Halifax.—Issued by the city of Halifax, N.S.

American Peat Society.—Ninety-eight page journal issued by the Society, Toledo, Ohio.

Works Administration.—28-page pamphlet issued by the Gunn, Richards & Company, New York.

Canadian Forestry Journal.—Pamphlet issued by the Canadian Forestry Association, Ottawa, Canada.

Some Mistaken Popular Notions Concerning Public Service Corporations.—By Frederick Strauss. Issued by the J. G. White Companies, New York.

Permissible Explosives.—Technical paper No. 52, by Clarence Hall. Issued by he Bureau of Mines, Department of the Interior, Washington, D.C.

Patents.—Official journal of patents of Great Britain, for June, 1913. Issued by the Patent Office, Southampton Building, Chancery Lane, London, W.C. Price, 6d.

Ohio State Board of Health.—April bulletin issued by the Board of Health, and contains interesting papers read before the Board by well-known medical men.

Properties of Saturated and Superheated Ammonia Vapor.—96-page bulletin by G. A. Goodenough and Wm. E. Mosher. Issued by the University of Illinois, Urbana, Ill.

Apparatus for Gas-Analysis Laboratories at Coal Mines.—Illustrated technical paper by G. A. Burrell and F. M. Seibert. Issued by the Bureau of Mines, Washington, D.C.

Magnetic Iron Sands.—Report by George C. MacKenzie, B.Sc., dealing with the investigation of the Natashkwan magnetic iron sands. Issued by the Department of Mines, Ottawa.

The Flash Point of Oils.—Technical paper dealing with methods and apparatus for its determination, by T. C. Allen and A. S. Crossfield. Issued by the Department of the Interior, Washington, D.C.

Mineral Production of Canada.—Annual report by John McLeish, B.A., containing revised statistical information descriptive of the mining and metallurgical production in Canada during the calendar year 1911. Issued by the Department of Mines, Ottawa.

American Wood Preservers' Association.—480-page booklet containing the proceedings of the ninth annual meeting of the American Wood Preservers' Association, held at Chicago, Ill. Issued by the society. F. J. Angier, secretary-treasurer, Baltimore, Maryland.

Report on the Livingstone Channel.—Contains the recommendations in reply to questions submitted by the Governments of the United States and Canada in regards the Channel. Issued by the International Joint Commission, Washington, D.C., and Ottawa, Ont.

Repair and Maintenance of Highways.—72-page illustrated bulletin by L. T. Hewes, Ph.D., dealing with the repair and maintenance of macadam roads of all kinds, gravel, sand-clay, and earth roads. Issued by the Department of Agriculture, Washington, D.C.

Minority Opinions, Kettle.—Bulletin dealing with dissenting opinions in regard to application of the Rainy River Improvement Company for approvement of plans for a dam at Kettle Falls. Issued by the International Joint Commission, Washington, D.C., and Ottawa, Ont.

Testimony in the Livingstone Channel.—225-page bulletin containing the references of the Governments of the United States and Canada under Article IX. of the treaty of May 5th, 1910. Issued by the International Joint Commission, Washington, D.C., and Ottawa, Ont.

Hearings and Arguments re Kettle Falls Dam.—128-page bulletin containing the hearings and arguments in the matter of the application of the Rainy River Improvement Company for approval of plans for a dam at Kettle Falls. Issued by the International Joint Commission, Washington, D.C., and Ottawa, Ont.

Highway Improvement.—Annual report of W. A. MacLean, chief engineer of highways, relating to highway improvement in the Province of Ontario, and containing the latest information on road construction, road metal, highway bridges and culverts, with illustrations. Issued by the Department of Public Works, Toronto, Ont.

The Year Book, 1912.—Containing the sixth annual report of the Council and transaction for 1912; also trade reports. Swedish traffic questions, with maps inserted of the city of London, railway and canal of Sweden, Blyth harbor, Port of Sutherland, River Tyne, Hartlepool docks, Hull docks, Immingham new dock and Port of Great Grimsby. Issued by the Swedish Chamber of Commerce in London, England.

Report of Water Commissioners, London, Ont.—Thirty-fourth annual report of the officials of the waterworks and electrical departments for the year ending November 30th, 1912, and the parks department for the year ending December 31st, 1912. It includes the general manager's reports and secretary's detailed statement of receipts and disbursements. Issued by the Waterworks, Electrical and Parks Department, London, Ont.

Cheap Steam and Machine-Firing.—A 27-page illustrated pamphlet dealing principally with the application of independent buckets, elevators and shoots to feed the stokers; construction and operation of the Gold Medal machine stoker; shows arrangement of machines for gas-firing as an alternative to coal-firing, and report of actual tests. Steam users will find drawings of the leading types of boilers especially interesting. Issued gratis to steam users by G. H. Tod, Manning Chambers, Queen Street West, Toronto.

CATALOGUES RECEIVED.

The Valve World.—Nicely illustrated catalogue. Issued by the Crane Company, Chicago, Ill.

Tobin Bronze.—Illustrated catalogue issued by American Brass Company, Ansinia Brass and Copper Branch, Ansinia, Conn.

Electric Service Magazine.—15-page illustrated catalogue. Issued by the Toronto Electric Light Company, Limited, Toronto.

Electric Arc Welding Apparatus.—Illustrated catalogue. Issued by the C. and C. Electric and Manufacturing Company, Garwood, New Jersey.

Labor Saver.—Illustrated catalogue on the efficiency and economy of production. Issued by the Stephens-Adamson Manufacturing Company, Aurora, Ill.

Sockets and Receptacles.—Third edition of supply catalogue, illustrated, contains 64 pages. Issued by the Canadian General Electric Company, Toronto.

Fuel Costs.—Eight-page pamphlet dealing with comparison of oil, gas and coal as a fuel. Issued gratis by the Tate-Jones & Company, Inc., Pittsburg, Pa.

J.-M. Packings and Specialties.—132-page, nicely illustrated catalogue, dealing with J.-M. asbestos products. Issued by the Canadian H. W. Johns-Manville Co., Limited.

Weber Chimneys.—48-page illustrated catalogue dealing with Weber coniform chimneys and methods of construction.

May be obtained on application from Weber Chimney Company, Chicago, Ill.

Robb Engine Boilers.—Illustrated catalogue in unique and original style. Issued by the International Engineering Works, Limited, formerly the Robb Engineering Company, Amherstburg, N.S.

Pneumatic Drills, Reamers, Wood Borers, Flue Rolling and Tapping Machines and Grinders. Illustrated catalogue. Issued by the Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill.

A Test by Technologists.—Contains the expert reports on the six years' weather tests of paint for steel on the Pennsylvania Railway Bridge at Havre de Grace, Md. Issued by the Lowe Bros. Company, Dayton, O.

The Road Models of the Office of Public Roads.—Descriptive catalogue illustrating the standard types of model road construction which represents the modern ideas of highway engineers. Issued by the United States Department of Agriculture, Office of Public Roads, Washington, D.C.

Chicago Pneumatic Tool Company have issued bulletin Nos. 128, 132 and 133 dealing with miscellaneous equipment of pneumatic drills, pneumatic motors and geared hoists and cylinder air-hoist and jacks, respectively. These may be obtained from the company, Fisher Building, Chicago, and 50 Church Street, New York.

The Purification of Water Supplies.—70-page illustrated catalogue containing a concise resumé of the nature of impurities usually found in natural water supplies and the modern methods adopted for effecting their removal. Deals with the physical characteristics of water, its impurities and quality in regards industrial purposes, methods of purification by storage, advantages and disadvantages of slow sand filtration, the advantages of the rapid system of filtration in general and the Paterson rapid system of filtration, gravity filter for industrial purposes, and the Paterson system of softening, sterilization and removal of iron in particular. Issued by the Paterson Engineering Company, Limited, 12 Norfolk Street, Strand, London, W.C.

NEW BOILER REGULATIONS FOR ONTARIO.

Following an act passed by the Ontario Legislature two sessions ago, regulations affecting the construction of boilers are to be brought into force on July 1st. Mr. D. M. Medcalf, who is public inspector of boilers for the province, has drafted regulations under the act which will henceforth compel manufacturers of boilers to submit plans and specifications to this branch of the Department of Public Works to insure a standard in both material and method of construction.

The regulations provide that all new boilers to be constructed in the province shall conform to a proper standard; second-hand boilers to which extensive repairs have been made will also be inspected. Until the present time practically any class of construction would go in the province, and boilers have been sold indiscriminately that have raised the danger risk to such an extent that human life has been impaired.

Twenty-four hundred miles of telephone wire will be strung by the employees of the Alberta department of telephones on rural lines this year, in addition to a large amount of long-distance line in construction and new exchange work in the growing towns and cities of the province. Over two million dollars will be expended by the government in extending the telephone system of Alberta during the year. At the beginning of the year there were in wire miles 9,671 miles of rural lines and 6,689 miles of long-distance telephone lines in **Alberta.**

COAST TO COAST.

Edmonton, Alta.—After examination into the possibilities of Rabbit Hills as the future source of a gravity supply of water for the people of the city of Edmonton, the commissioners have reported to the city council that they are not at all favorably impressed with it, but have faith in the present system proposition. First of all the Montreal experts, whose services in connection with their report on the city's water system cost $15,000, suggested that the plant at the present site be improved and extended to take care of Edmonton's requirements, now and for the future. That recommendation was turned down by the council owing to the fear that at some time heavy floods might submerge the flats and render the pumping and power station situated thereon useless, thereby depriving the citizens of light, power and water at one fell swoop. It was then decided to accept the second suggestion of the experts, namely, to look to Rabbit Hills as the source of supply, and the commissioners were instructed to prepare surveys and plans of this system. This they have apparently done, with the result that they have advised council not to proceed with its intention to obtain the city's water supply from that source, but rather to transfer their choice to the Beaver Hills proposition. When this report was read at a recent meeting of the council the members of that body seemed at first too taken aback to say very much, though some scathing criticisms of the commissioners were forthcoming later. Finally, on the motion of Ald. Tipton, it was agreed to instruct the commission board to proceed with their work of preparing plans and surveys of the Rabbit Hills scheme as set forth in the report of the Montreal experts, and as endorsed by resolution of the city council.

Saskatoon, Sask.—Although Saskatoon has cheaper steam-generated electric power than any other city in the prairie provinces, the city commissioners are taking steps to secure electricity at an even cheaper rate. The necessity for this is greatly emphasized by the government's announcement of the location of an interior storage elevator at Saskatoon. As the structure now to be erected, a five-million-bushel elevator, is but the first unit of what will eventually be an institution with a capacity of upwards of twenty-five million bushels, and as its establishment must of necessity tend to the development of the milling industry, and as a vigorous campaign for the securing of manufactories for Saskatoon is now in progress, the benefit which will accrue from any saving in the cost of power may readily be imagined. Commissioner Yorath, who has specialized in power problems, states that he has very definite prospects for cheaper power, these including three distinct propositions; one of these involves the generation of power at a point some 125 miles from Saskatoon and its transmission to the city; another includes possibly a more pretentious scheme which is being taken up with certain interests in London, Eng., and a third proposal, details of which are being considered.

Quebec, Que.—Honorable J. F. Caron, Minister of Agriculture, is very pleased with the results obtained so far through the policy of the good roads. There are fifty-eight gangs working at various points of the province, and all are going fast with the improved machinery supplied to them. The number of municipalities asking for money grants is ever on the increase and a sum of $5,000,000 has been paid by the government to the towns, villages and municipalities desirous to improve. This sum is exactly half the credit effected last year to these improvements. This sum, of course, does not include what the government is spending on large national roads. The Edward VII road will be the first com-

pleted, and the road between Montreal and Quebec is under way, the contractors having begun work from the western end of the road at Charlemagne. The road between Montreal and Ottawa will probably be built on the south bank of the Ottawa if the Province of Quebec can make arrangements with Ontario to build from St. Eugene to Ottawa.

Halifax, N.S.—Halifax has reason to be proud of and satisfied with the purity of its water. A sample was sent last month to Dr. J. T. Donald, Ottawa, official analyst to the Dominion Government. He was asked to make an analysis of the water as regards its suitability as a boiler feed water. Dr. Donald's reply was highly complimentary as to the value of the water for drinking purposes, with a report also regarding its use in boilers: "This is a remarkable water, containing as it does less than two grains of mineral matter per Imperial gallon. It is thus a very pure water. It is just possible it may be too pure for satisfactory use in boilers. We have had cases where a water with so little mineral matter had caused pitting and corrosion of tubes. This tendency was overcome by adding a small amount of lime to the water. If you will give us further particulars if you have any trouble in using this water we shall be glad to discuss the matter with you."

The analysis from a sample containing 10.5.13 was as below:—

	Grains per gallon.
Total solids	1.82
Sodium chloride	0.82
Carbonate of lime	0.25
Carbonate of magnesia	0.08
Iron oxide and alumina	0.11
Organic matter, etc.	0.56

Toronto, Ont.—The great host of Ontario people who yearly flock to the summer resorts of the north and the watering places about the fresh water system will this season enjoy a more adequate protection from unsanitary conditions than ever before. The efforts of the provincial board of health, which have been bent for several years towards the enforcement of efficient and cleanly methods of sewage disposal and water supply, are beginning to bear fruit. Dr. J. W. S. McCullough, chief health officer of Ontario, states that one great source of contamination has been removed in the adoption of high-class sewage systems on board the tourist steamers in the inland lakes. Five of these boats which ply constantly from point to point in the Muskoka region have installed septic tanks, and the intention of the department is that by next year every tourist line will be asked to submit to similar arrangements. Apart from the ordinary reaction of chemicals, which is set at work in all such plants, the additional precaution of turning live steam into the compartments for disinfection purposes will be followed. In this way no possible complaint as to the contamination of the water in the narrower channels or bays can occur in future. The general inspection of the cottages and hotels in the different parts of the province is being carried on at the present time. Owing to the activity of the department last year in forcing negligent proprietors into line, more satisfactory conditions are being experienced by the officials this year. District Officer Clinton, of Belleville, has completed an investigation of the Kawartha Lake region and with few exceptions has approved the methods. The Grimsby and Burlington Beaches at the present time are undergoing the investigation of Dr. McLenahan, of Hamilton, the board representative in that district. Because of the popularity of these places with a large class of people who cannot journey far from city life, the conditions are more congested. In consequence more difficulty is found in maintaining proper sanitary conveniences. A willingness to comply with the new regulations is now being met by the department, however. The installation of the new tanks on board ship was largely at the instigation of the shipowners, and hotel proprietors are gradually assuming the same attitude of co-operation.

Ottawa, Ont.—A party of surveyors is being sent out by the Public Works Department to prepare contract plans for the improvement to the French River in connection with which a vote of $500,000 was made at the last session. The river connects Georgian Bay and Lake Nipissing and would be one of the main sections of the Georgian Bay Canal if that great work were undertaken. Even if it were not, the improvements contemplated would facilitate navigation to the North Bay terminals from the Great Lakes. The principal improvements necessary are a system of controlling dams to regulate the level of the lake and two or three locks. The vote made last session is sufficient for carrying out the preliminary details and commencing construction. With regard to the Georgian Bay Canal project, it is intended, as announced by Hon. Mr. Rogers, to appoint a commission to enquire into the commercial feasibility of the project. From an engineering point of view, the feasibility of the undertaking has been fully established, but there is a singular lack of information as to the extent to which the canal, when built, would be utilized and become one of the great transportation routes of the country, as it is destined to be. It is not certain as yet as to when the commission will be appointed, but when it is, different parts of the country will be visited and evidence taken. Upon the report which is made will depend very largely whether or not the proposition will be gone ahead with by the government.

St. Boniface, Man.—In reference to the notice received from the Canadian Federation of Boards of Trade, the St. Boniface board have voted to support the Georgian Bay Canal scheme in opposition to the scheme of the United States to divert the great waterway to the United States waters, the Canadian plan calling for an expenditure of $75,000,000, as against the United States scheme of $51,000,000. The St. Boniface board is pledged to use its influence in favor of the Georgian Bay Canal, and to urge its members of parliament at Ottawa to support the project in the House.

Ottawa, Ont.—A peculiar case of unsatisfactory tenders is now before the Government, and after some weeks' consideration is still undecided. It is a contract for a building costing a million and a half dollars. Tenders were invited and received, but the lowest one was $200,000 below the estimate and $500,000 below the other bids. It came from a new and inexperienced firm, though accompanied by a heavy deposit cheque. New tenders were called, and instead of dropping out, the contractor has practically repeated the offer. The next lowest tender is from a firm whose work is very unsatisfactory. The situation is a delicate one because the work is being held back, and if the usual custom of accepting the lowest tender or the next one above is not followed there will be criticism. All of the big and reputable firms are away above the others. Meanwhile nothing is being done, and what solution will be arrived at is uncertain.

Victoria, B.C.—Four Cabinet Ministers will visit Victoria this summer, namely: Hon. Robert Rogers, Hon. J. D. Hazen, Hon. H. P. Pelletier and Hon. W. T. White. Mr. Rogers' visit is, of course, the most important, as under his department comes the work of construction of the Victoria harbor works and the Esquimalt drydock. The plans for the breakwater and piers for Victoria are being prepared by the Engineering Department of the Public Works at the present time, and the call for tenders will be issued within

a few weeks. As for the Esquimalt drydock, which will be included in part of the permanent naval policy of the Government, nothing can be done until a complete survey is made of the harbor. It is understood that a party will leave at once to undertake this work; and Mr. Rogers states that construction will be rushed with all possible speed.

Saskatoon, Sask.—According to civic authorities, cheap power is the chief requirement of Saskatoon to make it a milling centre. If a low rate of power is obtainable, it is only a matter of a short time until large mills will be under construction. It is understood that Hydro-Electric developments are shortly to receive consideration. It is the opinion of several engineers around the city that to make the power scheme profitable two dams will have to be built in the river. The Saskatchewan River probably carries more sand down with it than any other river in the Dominion. The idea now is to build a dam far up the river in the neighborhood of Pike Lake, which would act as a breakwater and hold all the silt which would otherwise drift down the river and form against the real dam, which is to supply the head water, which will make the wheels go round. If this is not done all the sand silt will form a drift up against the real dam, and thus spoil the head of water to a material degree. It is now seven years since Saskatoon first investigated the potentialities of the South Saskatchewan River with a view of producing power. At that time Saskatoon paid Engineer Mitchell, of the Ontario Hydro-Electric power scheme, $800.00 to report on the conditions of the river in the Saskatoon district with a view to securing the best of the different power sites in the vicinity of Saskatoon. There is a chance, on the other hand, that the visit to Prince Albert may mean the re-opening with that city of negotiations to take a block of power from their power-house at LaColle Falls. This opportunity was given to Saskatoon some time ago, but the city fathers did not embrace the scheme very heartily. If this is done, a right-of-way will have to be purchased between her and the site of the falls, a distance of something over a hundred miles.

Fort William, Ont.—Good progress is being made by the 200 men, who, with about 40 teams, are clearing and grading roads in the district for the Ontario Government. At present some 80 men and 30 teams are engaged on the Oliver Road, about two miles from Port Arthur. The men in charge of the work report that no unlooked for obstacles have been met with. Another large crew of laborers are working on the Pigeon River Road, which is ultimately to connect Fort William and Port Arthur and Duluth. It is intended to have the Pigeon River Road cleared and graded as far as the Minnesota boundary line this fall. Work on the continuation of the highway has been commenced in Cook County, Minn.

Vancouver, B.C.—"Switzerland annually receives millions in revenue from her mountain scenery and I see no reason why we should not do so within the next few years," said Col. R. E. Thomson, provincial engineer of Strathcona Park at the Progress Club recently. There was, he added, everything in the island area that would appeal to the mountain climber. There were peaks of great height, crevasses, glaciers and "chimneys," a rather narrow opening in the rock in which mountain climbers delight. Strathcona Park, he said, would be made a place to which tourists the world over would be attracted. Camping places along the sides of the many lakes would be improved and put into proper condition. The large number of small lakes just west of the Beaufort range of mountains would be surrounded with camping settlements. Here children would be able to play close to nature, while all kinds of outdoor sports could be indulged in. The land would be piped, thus assuring the campers of an adequate water supply and of a pure quality. The beaches about these lakes would furnish admirable places for bathing and swimming, while boating, canoeing and other aquatic sports would be fostered by the tranquil stretches of water which reflect the mountains close by. It is the purpose of the government, said Col. Thomson, to preserve all the curiosities of nature that would be found. Beaver dams and the work of the animals would be kept intact, so that people might see the real work of these creatures. The big trees which are in some cases over thirteen feet in diameter, would be left standing and proper supervision exercised to see that they were protected. Employees of the Strathcona Park, are now experimenting with flowers from the Himalaya Mountains to see if the same shrubs and roots can be grown in this province. The flora in the park would, he thought, equal that about Mount Rainier to the south. Nowhere could the wishes of the alpine climber be better satisfied than in Strathcona Park.

PERSONAL.

MR. T. F. SUTHERLAND, assistant inspector of mines, now resident in Cobalt, comes to Toronto on July 1st to assume his duties as chief inspector of mines for Ontario.

MR. A. P. HAZEN, who has been in the employ of the Dominion Government at Ottawa, on the design of the Port Nelson terminal of the Hudson Bay Railway, has just resigned.

PROF. V. I. SMART, of McGill University, department of railway engineering, is leaving to assume the position of general manager for the General Railway Signal Company, of Canada.

MR. D. W. McLAUGHLIN, of the engineering staff of the Hudson Bay Railway, has just left for Port Nelson to conduct survey work in connection with the establishment of the railway's terminals at that point.

MR. E. T. CORKILL, who has been chief inspector of mines in Ontario for some years, has just accepted a position with the Canadian Copper Company, at Copper Cliff. The office is that of safety engineer, and is the first of its kind in Ontario.

MR. GEORGE IRVING has been appointed Canadian manager for the National Meter Company, of New York, and not Mr. George Irvine, as stated in a recent issue of *The Canadian Engineer.* Mr. Irving will make his headquarters at 229 Spence Street, Winnipeg.

MR. R. E. HORE, Mem. Am. Inst. M.E., and for some years instructor in Geology and Petrography, Michigan College of Mines, succeeds Mr. J. C. Murray, resigned, as editor of the "Canadian Mining Journal," Toronto. He graduated from the University of Toronto in 1905.

MR. J. G. SEYFRIED, structural engineer and assistant to the chief engineer, Grand Trunk Railway, at Montreal, has resigned to accept an appointment as engineer, Bridge Department, Canada Foundry Company, Limited, Toronto. Mr. Seyfried will have charge of the designing and estimating, and will become assistant to the manager of the Bridge Department, Mr. J. L. Brower, M.C.S.C.E.

HON. LOUIS CODERRE, secretary of state, who is now also minister of mines, that branch having been recently transferred to his portfolio, has decided this summer to make an extensive western trip, going as far as Dawson City. Mr. Coderre will travel west with the delegates of the International Geological Congress, which meets in Toronto in

August. He will visit all the important western mining centres and in that way will be able to make a personal study of the needs of the department, and to become intimately acquainted with the mining resources of the country.

MR. ARTHUR S. HERBERT has resigned his position as general manager of the Siemens Company of Canada, Limited, and has been appointed general manager of the branch offices of the Siemens Company in Australia. Mr. Herbert is now in England, but will return to Canada for a few weeks early next month, sailing for Australia from Vancouver about the end of August. He will be succeeded in Canada by MR. C. A. ABLETT, whose name has been closely associated with the electrification of the rolling mills in Europe during the past few years, and who recently made a brief investigation of the position of the large steel works of Canada with regard to electric drive. Mr. Ablett will take up his duties in Canada at the beginning of next month, but the appointment dates from the 1st inst.

COMING MEETINGS.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Annual Meeting in Regina September 16, 17 and 18. General Secretary, Major Drum, Ottawa; Local Secretary, Dr. Murray, Regina.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, P. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. H. W. Claudet, S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5, Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan, Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.